A330
TECHNICAL TRAINING MANUAL
MECHANICAL & AVIONICS COURSE - T1+T2 (LVL 2&3)
(RR Trent 700)
ELECTRICAL POWER

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ELECTRICAL POWER

Electrical Power Line Maintenance Briefing (2) 2

GENERAL

Electrical System General Description (3) 44

AC GENERATION

Main AC Generation D/O (3) 66
Auxiliary AC Generation D/O (3) 84
Emergency AC Generation D/O (3) 102
Contactors Management D/O (3) 124

DC GENERATION

Main DC Generation D/O (3) 156
Emergency DC Generation D/O (3) 164

LOAD DISTRIBUTION

Load Management D/O (3) 176
Refuel on Battery D/O (3) 182

ELECTRICAL POWER LINE MAINTENANCE BRIEFING (2)

SYSTEM OVERVIEW

The electrical system supplies Alternating Current (AC) and Direct Current (DC) power to the aircraft systems according to the different electrical power sources available:
- the AC generation,
- the DC generation.

Each engine drives an Integrated Drive Generator (IDG) supplying AC power. The APU drives an additional generator (APU GEN) which can supply all the A/C network on ground or replace a main generator in flight. Two Transformer Rectifiers (TRs) use the alternating current to supply the main direct current network. Another transformer rectifier (ESS TR) supplies the essential direct current network. Two batteries supply also direct current in some configurations. The APU TR or/and a battery (APU BAT) power supply the APU starter, depending on the A/C configuration. In case of major failure, a constant speed hydraulic motor drives an emergency generator: both equipments make an assembly called Constant Speed Motor/Generator (CSM/G). The function of the CSM/G is to supply the necessary systems to the A/C control.

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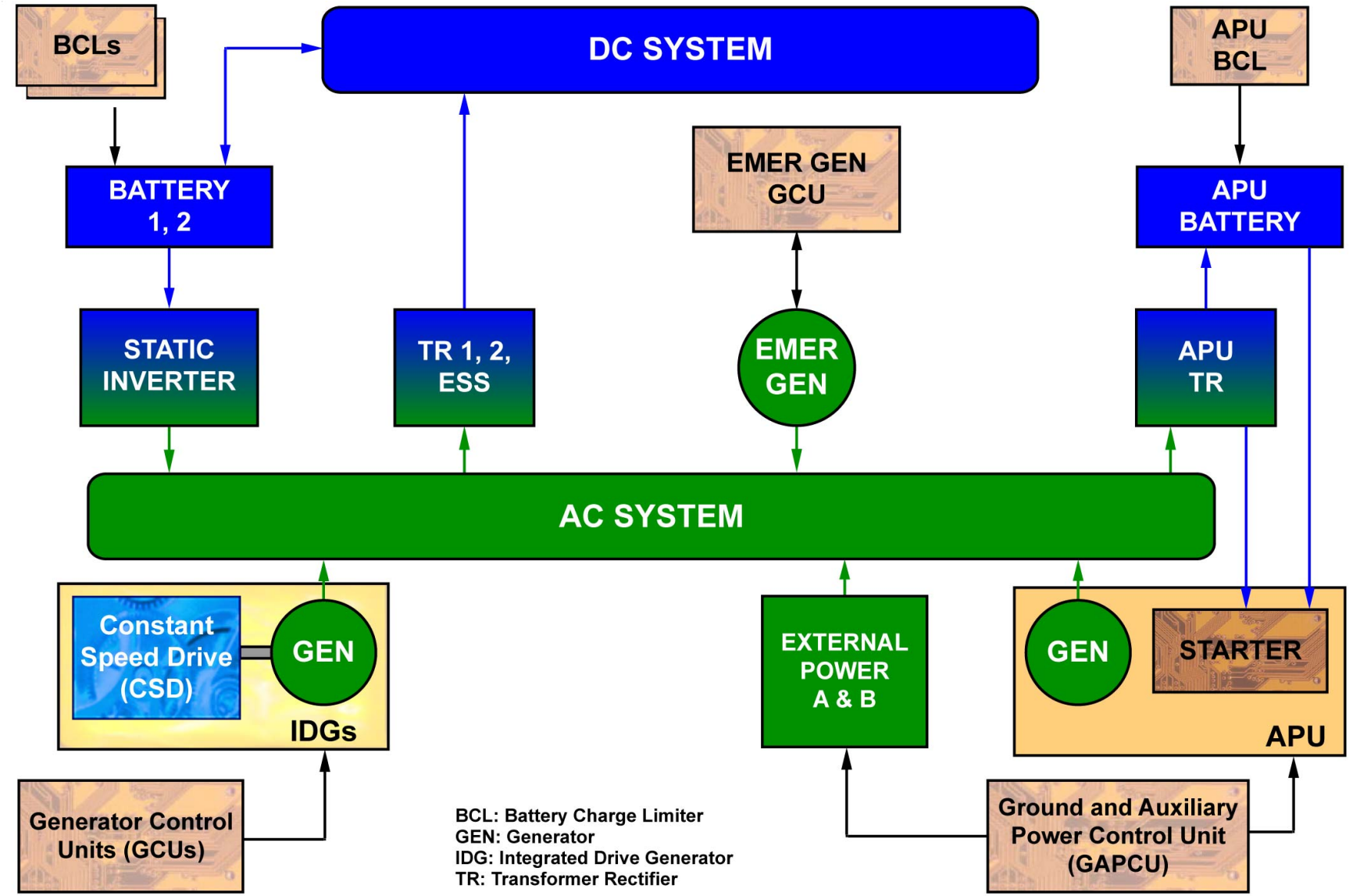

SYSTEM OVERVIEW

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ELECTRICAL POWER LINE MAINTENANCE BRIEFING (2)

INTRODUCTION

This module gives information related to the electrical power system basic line maintenance and necessary precautions to service and dispatch the IDG. This information must fulfill a good A/C grounding and bonding, and keep batteries serviceable in a cold soak configuration through the following tasks:
- A/C electrostatic balancing for maintenance operations,
- IDG oil servicing of general warnings and cautions,
- visual inspection of the oil level,
- check of the IDG oil-filter Differential Pressure Indicator (DPI),
- IDG servicing-filling of the IDG with oil or addition of oil after a level check,
- cold weather maintenance for batteries.

NOTE: As an example, and because of same IDG procedures on long range A/C, only the A340 IDG will be shown in this module.

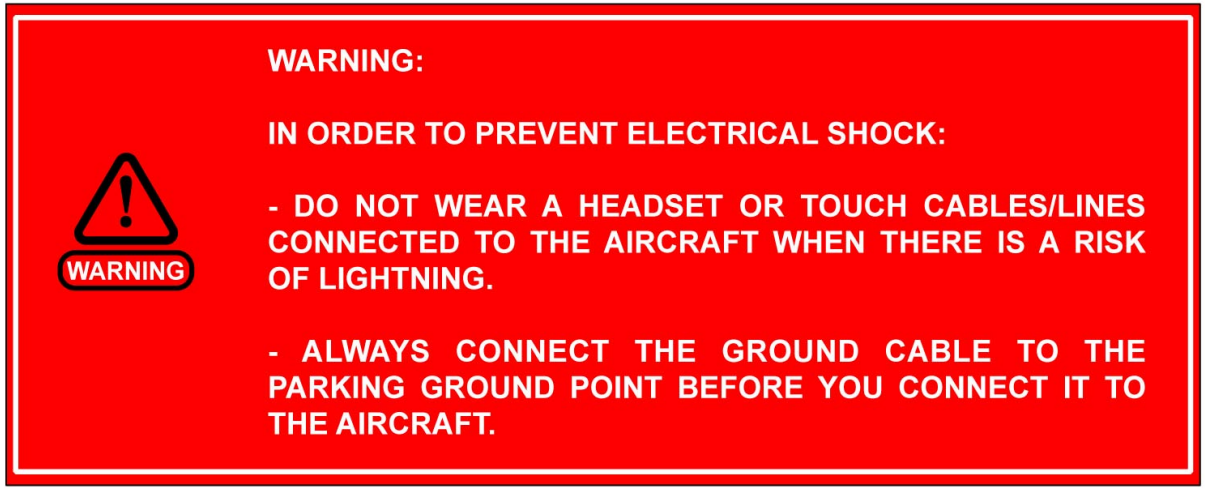
ENVIRONMENTAL PRECAUTIONS

Avoid use of the APU if APU BLEED air is not necessary. Turn-off unused ground service equipment (Ground Power Unit, air conditioning cart, etc...) if no work is being done or nobody is present on the aircraft.

A/C ELECTROSTATIC BALANCING FOR MAINTENANCE OPERATIONS

WARNING: In order to prevent electrical shock:
- do not wear a headset or touch cables/lines connected to the A/C when there is a risk of lightning,
- always connect the ground cable to the parking ground point before you connect it to the A/C.

NOTE: Grounding and bonding must be done with the correct grounding or bonding cable.


WARNING:
IN ORDER TO PREVENT ELECTRICAL SHOCK:
- DO NOT WEAR A HEADSET OR TOUCH CABLES/LINES CONNECTED TO THE AIRCRAFT WHEN THERE IS A RISK OF LIGHTNING.
- ALWAYS CONNECT THE GROUND CABLE TO THE PARKING GROUND POINT BEFORE YOU CONNECT IT TO THE AIRCRAFT.
WARNING

INTRODUCTION & A/C ELECTROSTATIC BALANCING FOR MAINTENANCE OPERATIONS

ELECTRICAL POWER LINE MAINTENANCE BRIEFING (2)

A/C ELECTROSTATIC BALANCING FOR MAINTENANCE OPERATIONS (continued)

GROUNDING

Grounding is recommended for maintenance and servicing operations in the hangar or outside. Connect the ground cable to the grounding points located at the MLG legs or NLG leg. The A/C is now grounded for maintenance operations.

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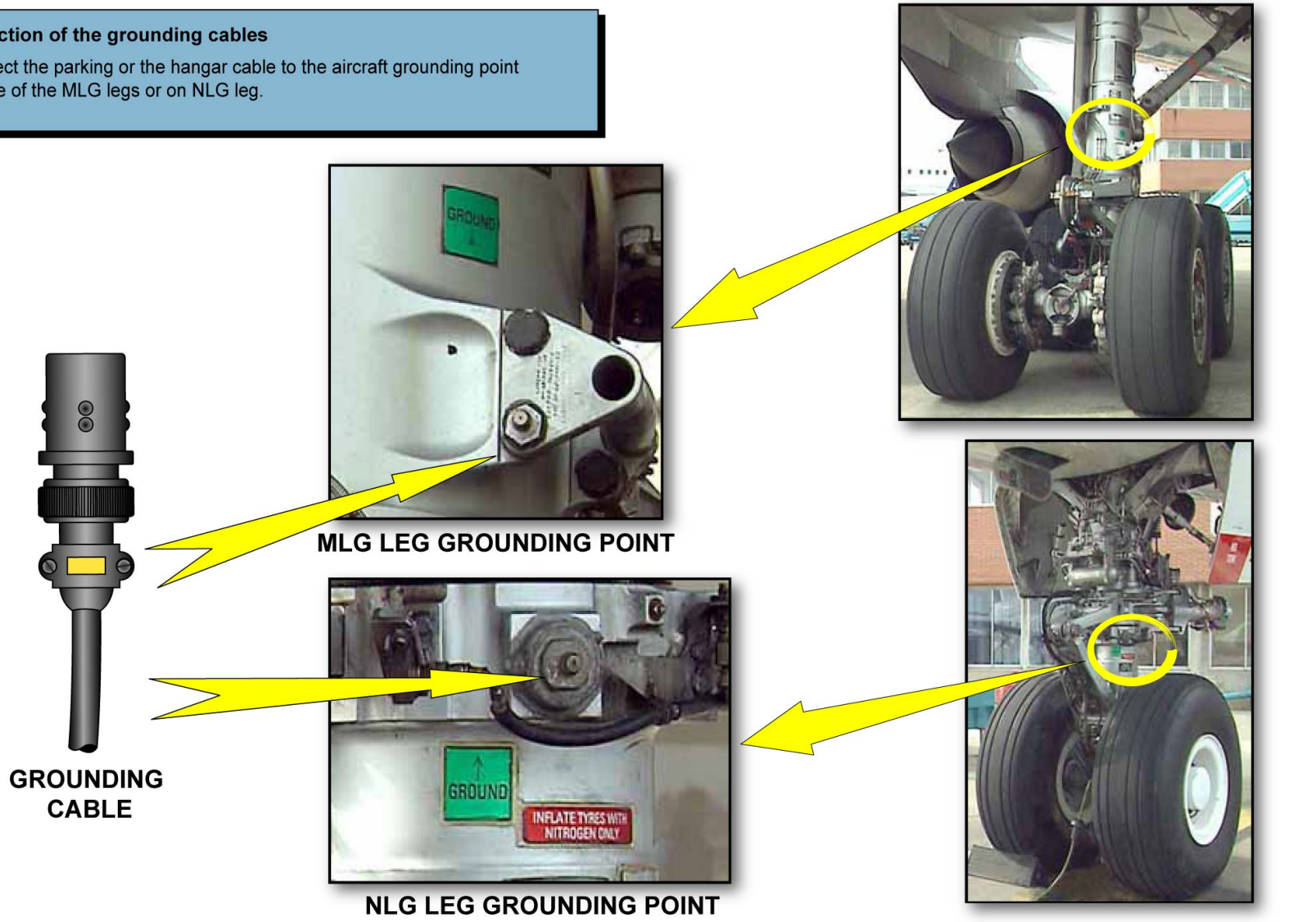
Connection of the grounding cables

Connect the parking or the hangar cable to the aircraft grounding point on one of the MLG legs or on NLG leg.



A/C ELECTROSTATIC BALANCING FOR MAINTENANCE OPERATIONS - GROUNDING

ELECTRICAL POWER LINE MAINTENANCE BRIEFING (2)

A/C ELECTROSTATIC BALANCING FOR MAINTENANCE OPERATIONS (continued)

GROUNDING (A330-200F)

An additional grounding point is installed adjacent to the HP connectors of the air conditioning system in the belly fairing.

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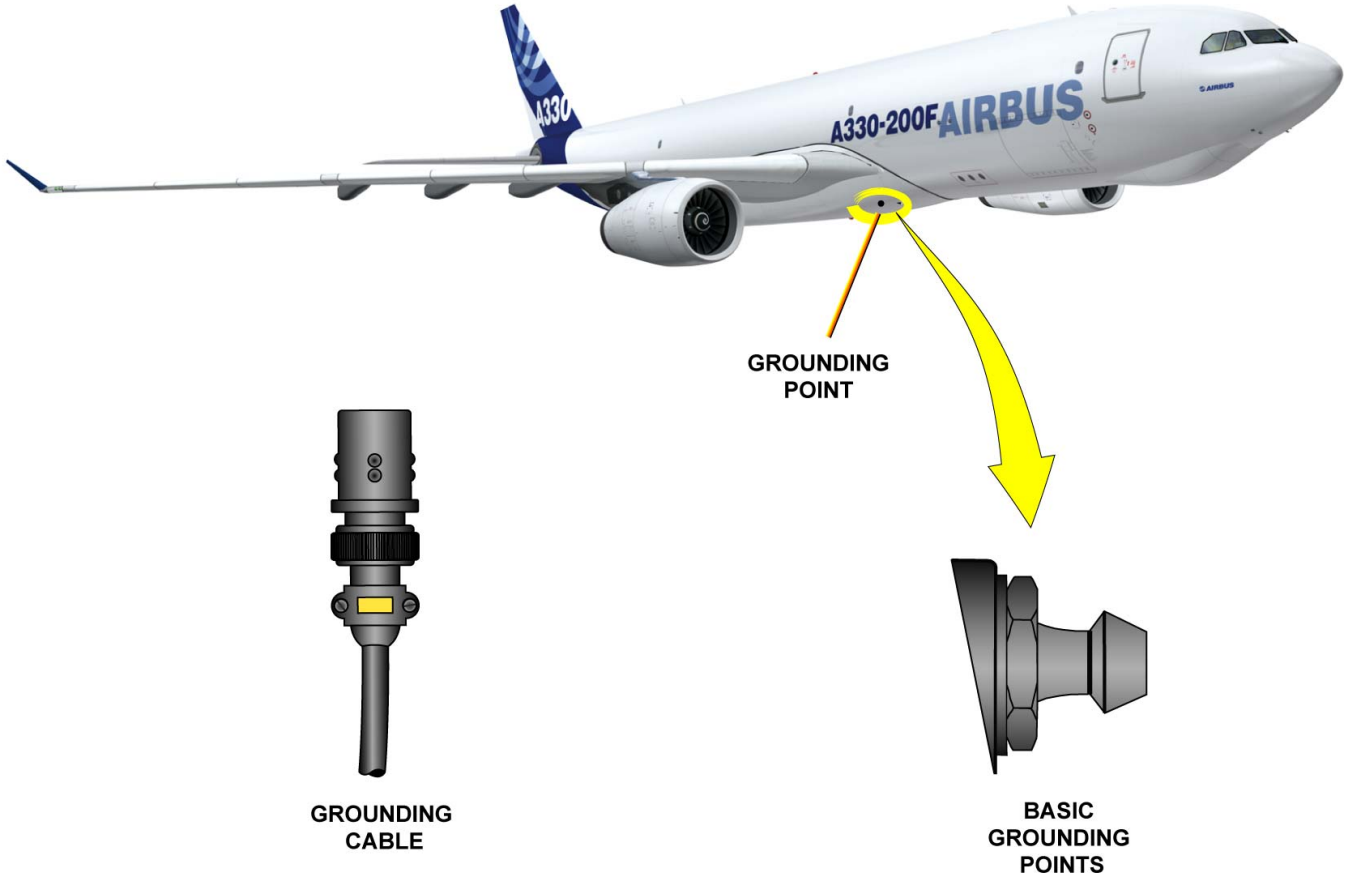
Connection of the grounding cables

An additional grounding point is installed adjacent to the HP connectors of the air conditioning system in the belly fairing.



A/C ELECTROSTATIC BALANCING FOR MAINTENANCE OPERATIONS - GROUNDING (A330-200F)

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ELECTRICAL POWER LINE MAINTENANCE BRIEFING (2)

A/C ELECTROSTATIC BALANCING FOR MAINTENANCE OPERATIONS (continued)

BONDING

To reduce the risk of explosion, bonding is necessary for refuel/defuel and oxygen servicing operations. This bonding supplies an electrostatic balancing between the A/C and the servicing device. Connect the bonding cable to the servicing device (fuel tanker or the oxygen ground filling equipment). Connect the other tip of the bonding cable to the A/C grounding points located on MLG legs, or NLG leg. The A/C is now bonded for servicing.

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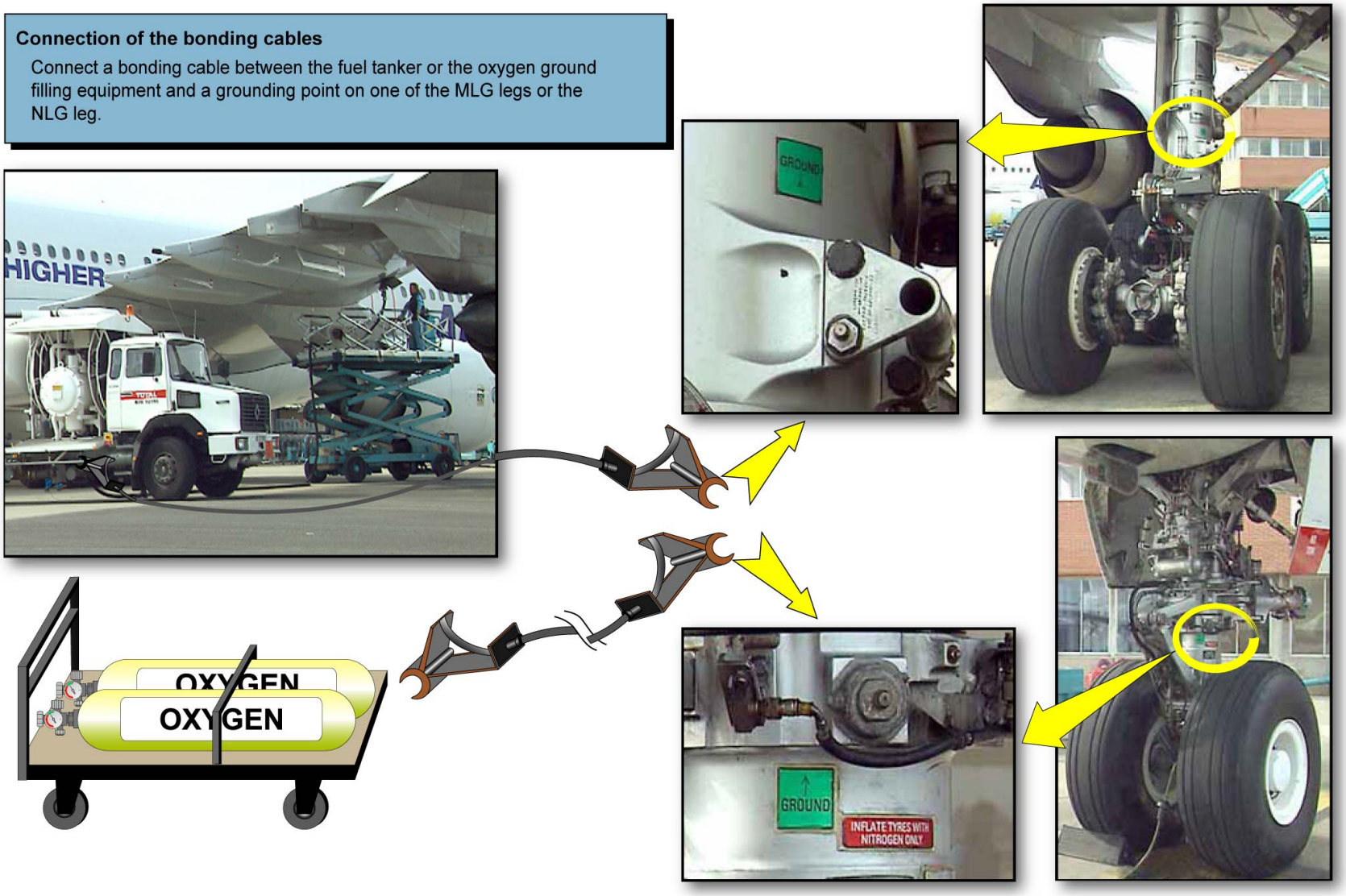
Connection of the bonding cables

Connect a bonding cable between the fuel tanker or the oxygen ground filling equipment and a grounding point on one of the MLG legs or the NLG leg.



A/C ELECTROSTATIC BALANCING FOR MAINTENANCE OPERATIONS - BONDING

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ELECTRICAL POWER LINE MAINTENANCE BRIEFING (2)

IDG OIL SERVICING GENERAL WARNINGS AND CAUTIONS

Follow the AMM instructions; they give the precautions to be taken during the servicing on the IDG.

WARNING: Beware of hot temperature and remaining oil pressure after engine stop.
Use proper safety wear.

CAUTION: IDG with an incorrect servicing can lead to serious damage.
Use approved tooling and approved oil types and brands for servicing and maintenance.
To prevent oil contamination, use solvents (chlorine) and water (rain, fog, wet conditions) with care and use only new oil cans.
A disconnected IDG must be troubleshot prior to any servicing operation.

NOTE: SAFETY PRECAUTION NOTE: Make sure that people cannot start the engines (open, safety and tag the related circuit breakers).

Following the AMM procedures, you can now work safely.

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IDG oil servicing general warnings and cautions

WARNING

BEWARE OF HOT TEMPERATURE AND REMAINING OIL PRESSURE AFTER ENGINE STOP.

USE PROPER SAFETY WEAR.

CAUTION

IDG WITH AN INCORRECT SERVICING CAN LEAD TO SERIOUS DAMAGE.
USE APPROVED TOOLING AND APPROVED OIL TYPES AND BRANDS FOR SERVICING AND MAINTENANCE.
TO PREVENT OIL CONTAMINATION, USE SOLVENTS (CHLORINE), AND WATER (RAIN, FOG, WET CONDITIONS) WITH CARE AND USE ONLY NEW OIL CANS. A DISCONNECTED IDG MUST BE TROUBLESHOT PRIOR TO ANY SERVICING OPERATION.

SAFETY PRECAUTION NOTE:

MAKE SURE THAT PEOPLE CANNOT START THE ENGINES (OPEN, SAFETY AND TAG THE RELATED CIRCUIT BREAKERS).

IDG OIL SERVICING GENERAL WARNINGS AND CAUTIONS

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ELECTRICAL POWER LINE MAINTENANCE BRIEFING (2)

VISUAL INSPECTION OF THE OIL LEVEL

This task describes how to check the IDG oil level.

NOTE: Before doing an IDG oil level inspection, if you replace any of the oil system components (filter, external system component, drain plug), a dry motoring is necessary for an IDG oil leak check.
Before doing an IDG oil level inspection, in order to get maximum filling of the external IDG oil system it is recommended to do:
- 2 minutes engine dry motoring,
- or an engine start at minimum idle thrust as an alternative procedure.

In both cases, wait five minutes to get a stable IDG oil level and then look at the IDG oil level sight-glass.
After an engine dry motoring (cold oil):
- if the oil level is within the green band, oil servicing is not necessary,
- if the oil is below or above the green band, follow the servicing steps.

After an engine start (hot oil):
- if the oil is within the green or yellow band, oil servicing is not necessary,
- if the oil level is below the green band or above the yellow band, follow the servicing steps.

IDG is now serviced.

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Visual inspection of the oil level.

Check of the oil level:

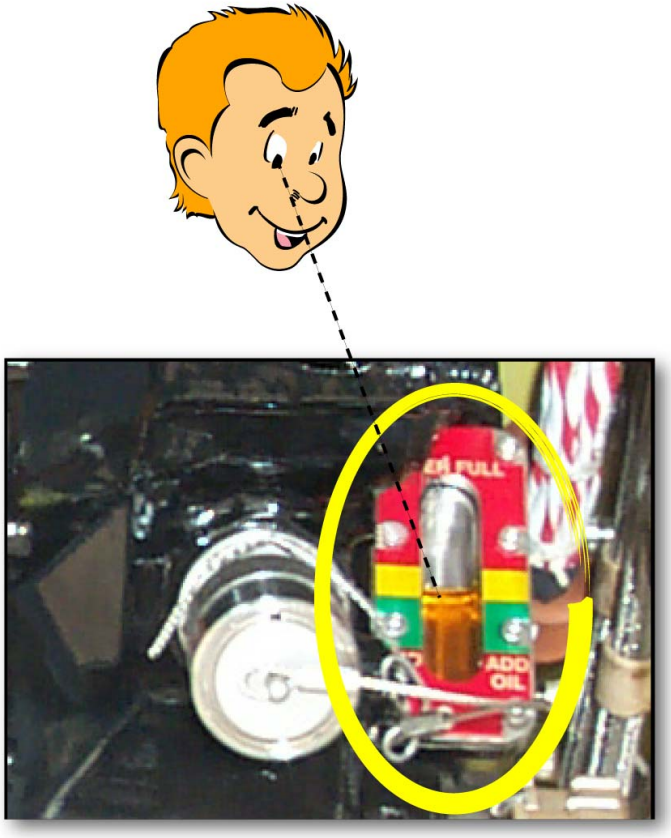
- Let the oil become stable after engine shutdown.
- Examine the sight-glass to do a check of the IDG oil level.

This procedure is described for training only, use the relevant AMM task as a reference.

Before doing an IDG oil level inspection, if you replace any of the oil system components (filter, external system component, drain plug), a dry motoring is necessary for an IDG oil leak check.

Before doing an IDG oil level inspection, in order to get maximum filling of the external IDG oil system it is recommended to do:
- 2 minutes engine dry motoring,
- or an engine start at minimum idle thrust as an alternative procedure.

To get a stable IDG oil level after an engine dry monitoring or start, wait five minutes.

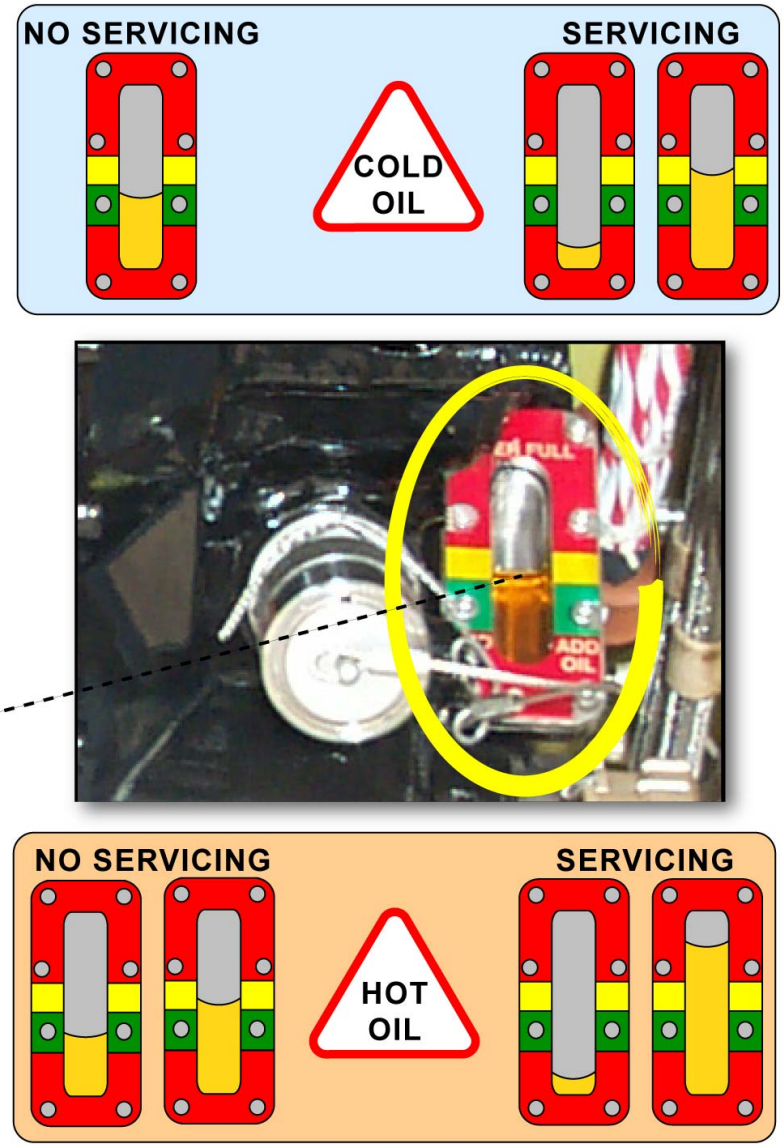


VISUAL INSPECTION OF THE OIL LEVEL

Visual inspection of the oil level.

Check of the oil level:

- ✓ **Inspection with or without dry motoring:**
  - **if the oil level is at or near the top of the green band, oil servicing is not necessary,**
  - **if the oil level is below the green band or above the green band, perform the servicing steps.**
- ✓ **Inspection after an engine start:**
  - **if the oil level is in the green or yellow band, oil servicing is not necessary,**
  - **if the oil level is below the green band or above the yellow band, perform the servicing steps.**



VISUAL INSPECTION OF THE OIL LEVEL

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ELECTRICAL POWER LINE MAINTENANCE BRIEFING (2)

CHECK OF IDG OIL-FILTER DIFFERENTIAL PRESSURE INDICATOR (DPI)

This task describes the procedure for an inspection of the Differential Pressure Indicator (DPI). Make sure that the red DPI is not extended. You can use a lamp or a mirror for a better inspection. If the red DPI is extended, refer to the Trouble Shooting Manual (TSM). The TSM alternate procedure is used for the reset of the DPI as an alternative to the replacement of the IDG. A maximum of 3 resets is allowed. If after a DPI reset the DPI does not extend again between two scheduled oil/filter changes, the DPI reset status goes back to zero (a maximum of 3 more resets is allowed).

NOTE: 1: At each DPI reset, you must also do the following maintenance actions: replacement of both the oil filter and the IDG oil filter.
2: If metal particles are found in the IDG oil filter, the IDG must be replaced.

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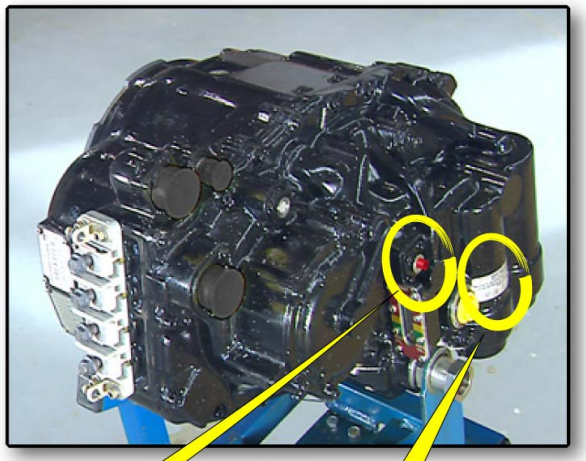
Visual inspection of the oil filter DPI:

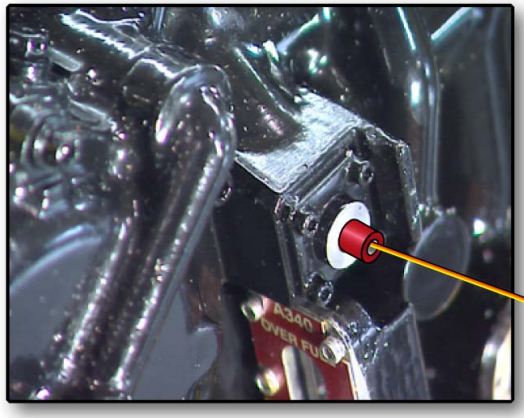
Make sure that the red button of the DPI is not extended:
-Use an inspection lamp and an inspection mirror, if necessary.

If the red button is extended from the end of the DPI:
-Do the alternate procedure.

This procedure is described for training only,
use the relevant AMM and TSM tasks as a reference.



IDG



DPI

DPI RESETS

REFER TO APPROPRIATE DOCUMENTATION FOR DETAILS OF THE ALTERNATE DPI PROCEDURE

1 ✓ 2 3 4 REMOVE IDG

TSM ALTERNATE DPI RESET PROCEDURE

Tick the placard after each DPI reset

DPI: Differential Pressure Indicator

CHECK OF IDG OIL-FILTER DIFFERENTIAL PRESSURE INDICATOR (DPI)

ELECTRICAL POWER LINE MAINTENANCE BRIEFING (2)

IDG SERVICING - FILLING OF THE IDG WITH OIL OR ADDITION OF OIL AFTER A LEVEL CHECK

IDG oil servicing is necessary if:
- an IDG oil level at the sight glass is not correct,
- an "IDG low oil level" message is generated by the Central Maintenance System (CMS),
- an IDG is replaced,
- an IDG is drained,
- an IDG oil filter is replaced,
- an IDG oil cooling system component is replaced.

Do not discharge products such as oil, fuel, solvent, lubricant either in trash bins, soil or into the water network (drains, gutters, rain water, waste water, etc...). Each product must be stored in an appropriate and specific cabinet or room such as a fire-resistant and sealed cupboard.

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IDG servicing - Filling of the IDG with oil or addition of oil after a level check:

- Depressurize the IDG case,
- Filling of the IDG with oil,
- Removal of the hoses,
- IDG oil level inspection.

This procedure is described for training only, use the relevant AMM task as a reference.

IDG SERVICING - FILLING OF THE IDG WITH OIL OR ADDITION OF OIL AFTER A LEVEL CHECK

ELECTRICAL POWER LINE MAINTENANCE BRIEFING (2)

IDG SERVICING - FILLING OF THE IDG WITH OIL OR ADDITION OF OIL AFTER A LEVEL CHECK (continued)

DEPRESSURIZE THE IDG CASE

CAUTION: Hard metal objects such as screwdrivers can cause damage to the overflow drain valve seat.

Put the end of the overflow drain hose fitting in a container. Then connect the overflow drain hose fitting to the overflow drain valve.

NOTE: Some oil can come out of the overflow drain hose fitting when you connect it.

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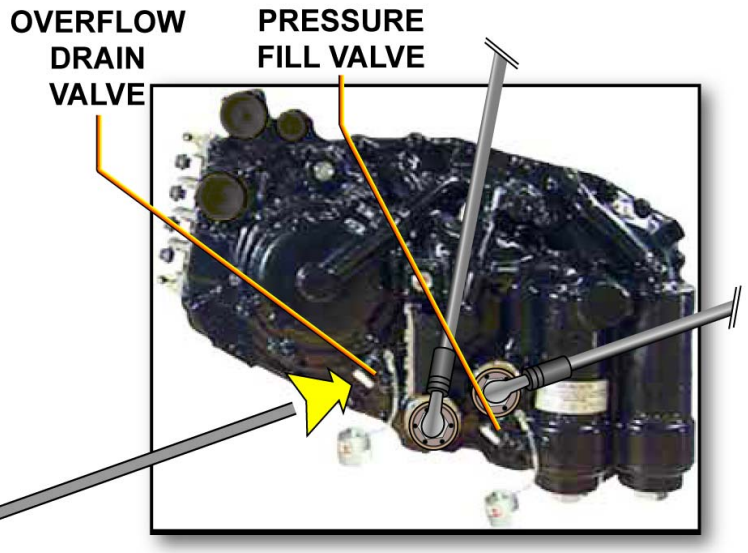
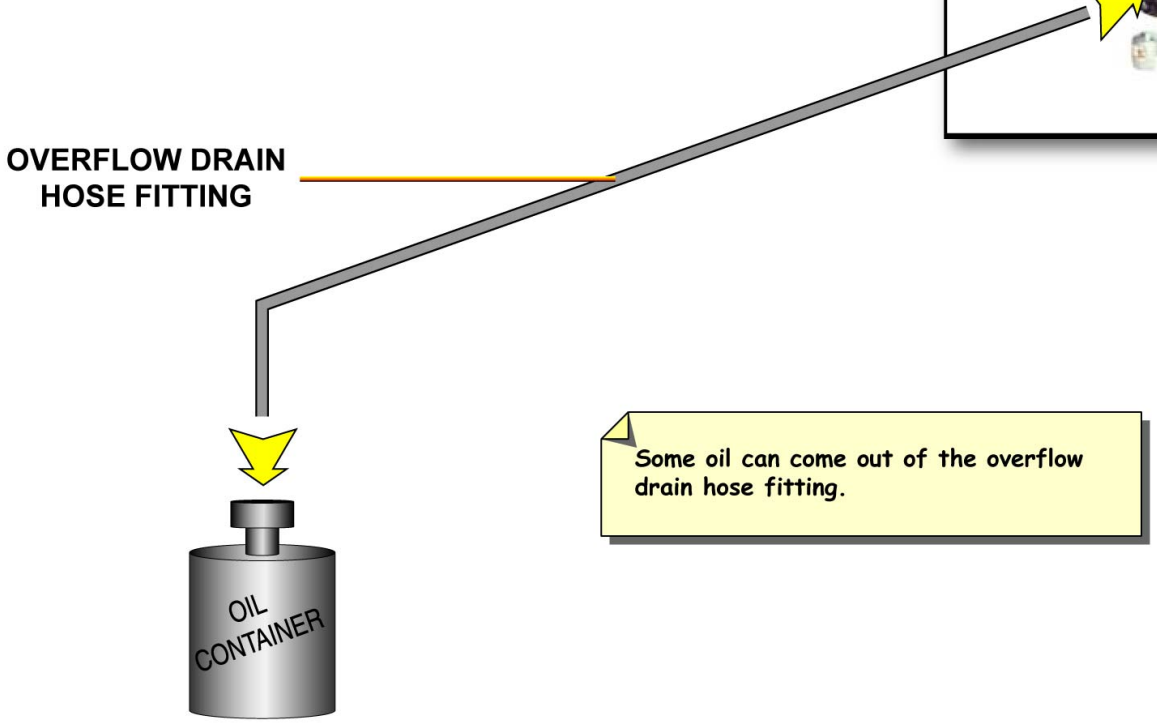
Depressurize the IDG case:

- Put the end of the overflow drain hose fitting in a container.
- To depressurized the IDG case, connect the overflow drain hose fitting to the overflow drain valve.





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IDG SERVICING - FILLING OF THE IDG WITH OIL OR ADDITION OF OIL AFTER A LEVEL CHECK - DEPRESSURIZE THE IDG CASE

ELECTRICAL POWER LINE MAINTENANCE BRIEFING (2)

IDG SERVICING - FILLING OF THE IDG WITH OIL OR ADDITION OF OIL AFTER A LEVEL CHECK (continued)

FILLING OF THE IDG WITH OIL

Connect the pressure fill hose fitting to the pressure fill valve. Fill the IDG with filtered oil and respect maximum filling pressure.
Stop the filling procedure when the quantity of oil collected from the overflow drain hose is above the minimum required.

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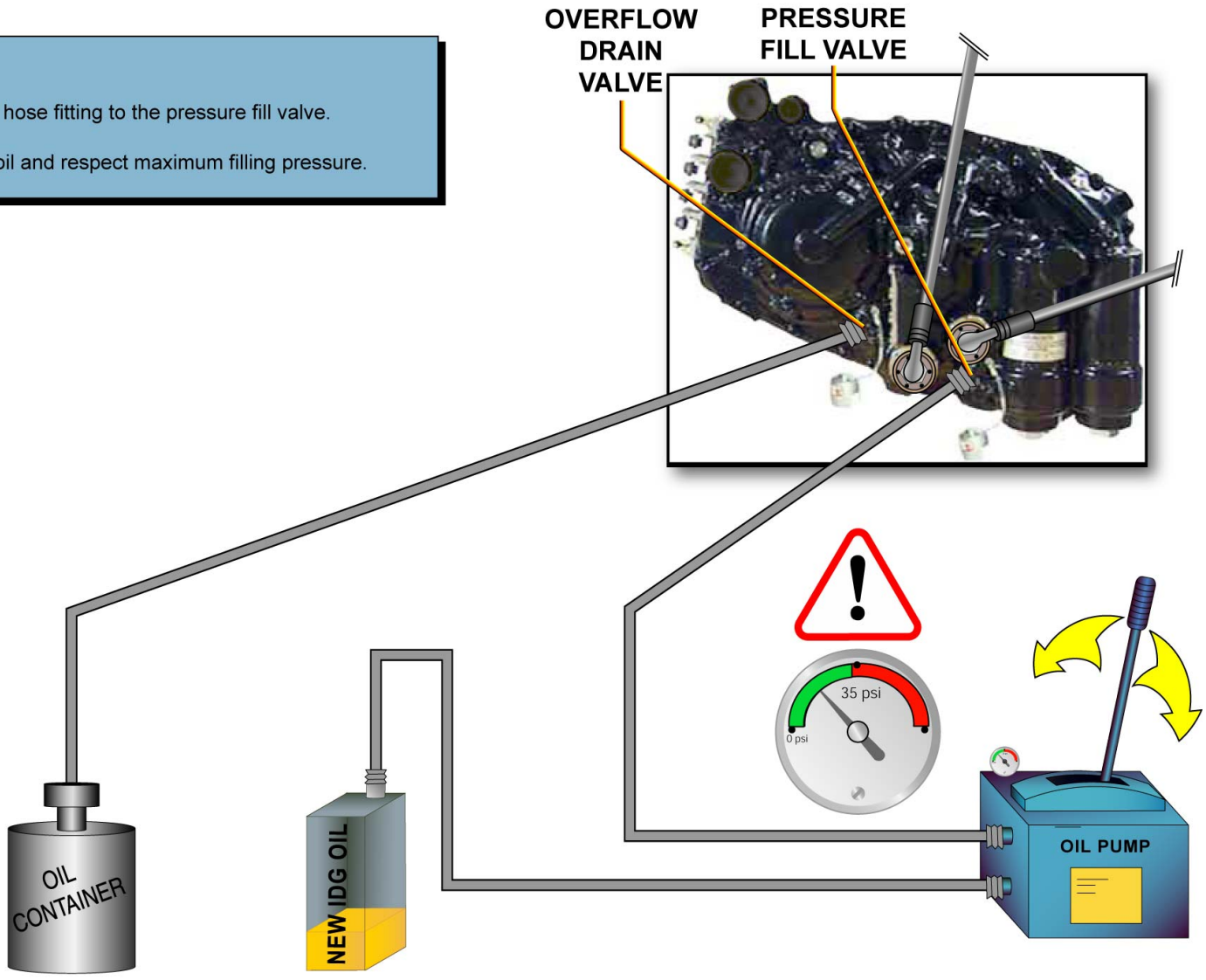
Filling of the IDG with oil:

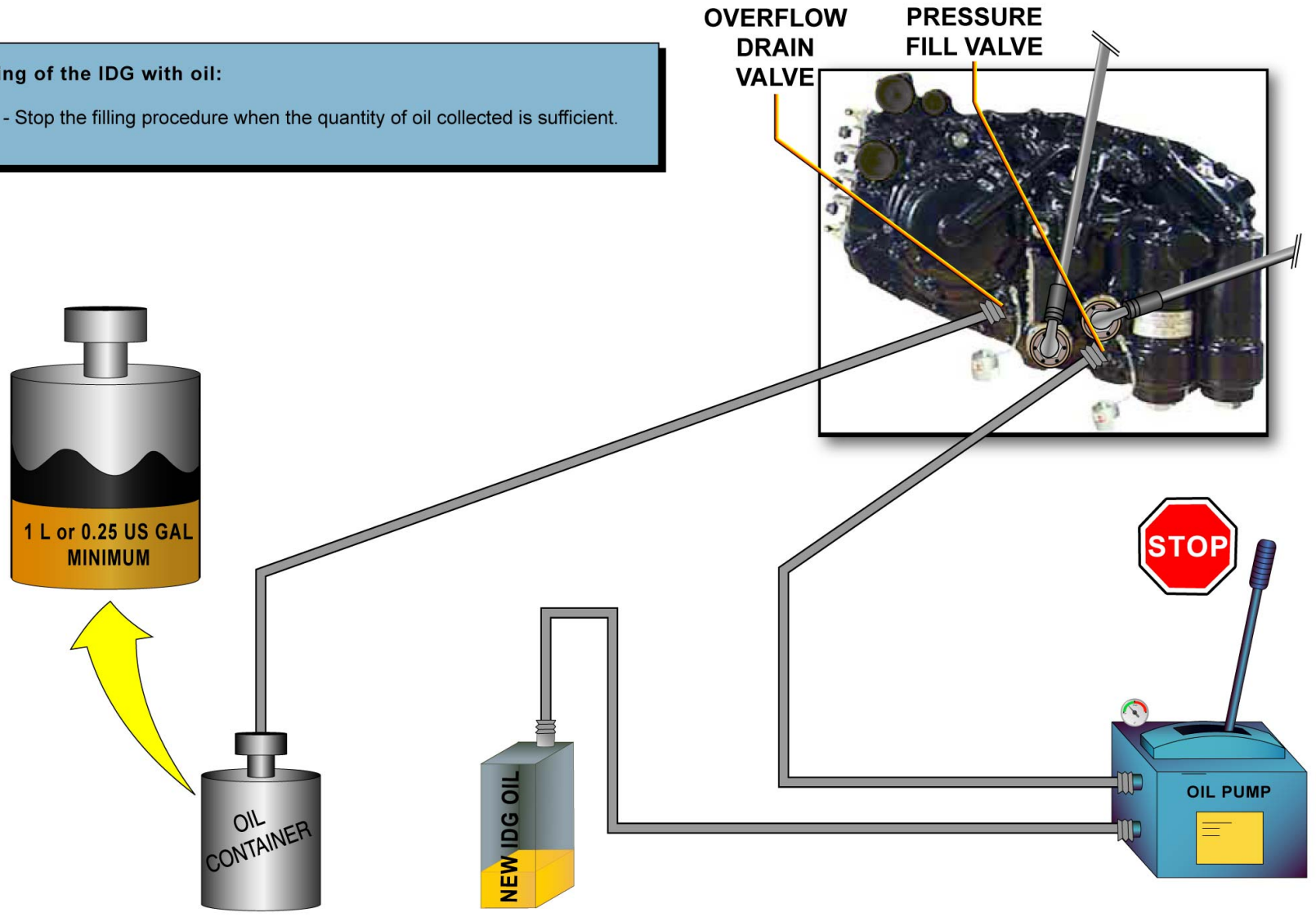
- Connect the pressure fill hose fitting to the pressure fill valve.
- Fill the IDG with filtered oil and respect maximum filling pressure.



IDG SERVICING - FILLING OF THE IDG WITH OIL OR ADDITION OF OIL AFTER A LEVEL CHECK - FILLING OF THE IDG WITH OIL

Filling of the IDG with oil:

- Stop the filling procedure when the quantity of oil collected is sufficient.



IDG SERVICING - FILLING OF THE IDG WITH OIL OR ADDITION OF OIL AFTER A LEVEL CHECK - FILLING OF THE IDG WITH OIL

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ELECTRICAL POWER LINE MAINTENANCE BRIEFING (2)

IDG SERVICING - FILLING OF THE IDG WITH OIL OR ADDITION OF OIL AFTER A LEVEL CHECK (continued)

REMOVAL OF THE HOSES

Disconnect the pressure fill hose from the pressure fill valve. When only drops of oil come out of the overflow drain hose, disconnect it. Do not forget to install the dust caps back on their related valves.

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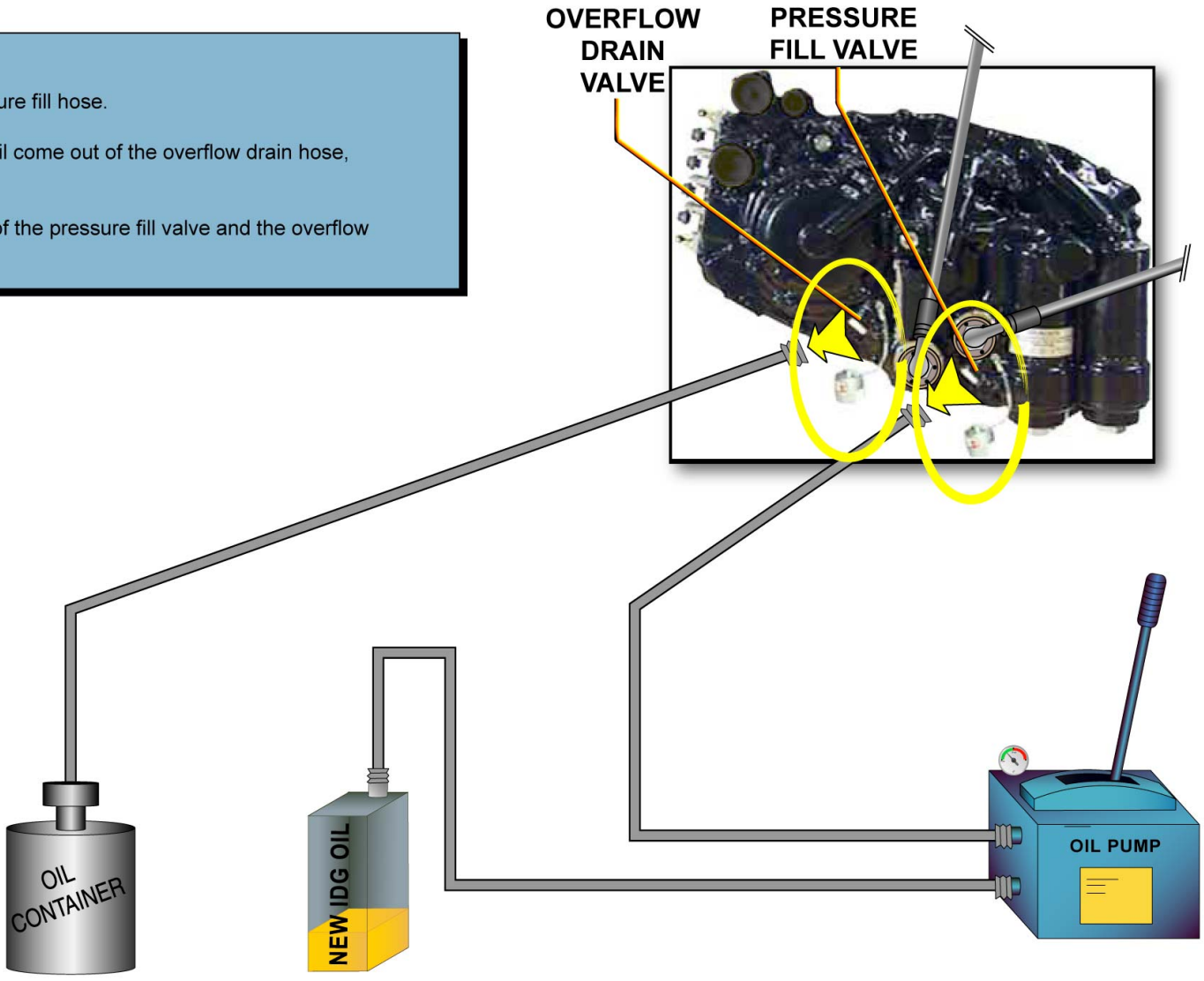
Removal of the hoses:

- Disconnect the pressure fill hose.
- When only drops of oil come out of the overflow drain hose, remove the hose.
- Install the dust caps of the pressure fill valve and the overflow drain valve.



IDG SERVICING - FILLING OF THE IDG WITH OIL OR ADDITION OF OIL AFTER A LEVEL CHECK - REMOVAL OF THE HOSES

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ELECTRICAL POWER LINE MAINTENANCE BRIEFING (2)

IDG SERVICING - FILLING OF THE IDG WITH OIL OR ADDITION OF OIL AFTER A LEVEL CHECK (continued)

IDG OIL LEVEL INSPECTION

At the end of the IDG servicing procedure, you must do an inspection of the IDG oil level, and do a reset of the oil level sensor by an action on the cockpit on the related GENerator P/BSW. Now, the IDG has a correct oil level.
Example of IDG servicing film.

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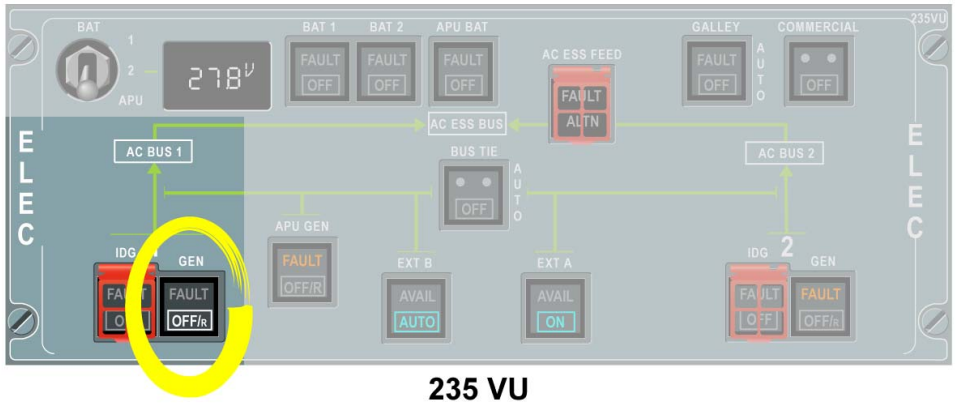
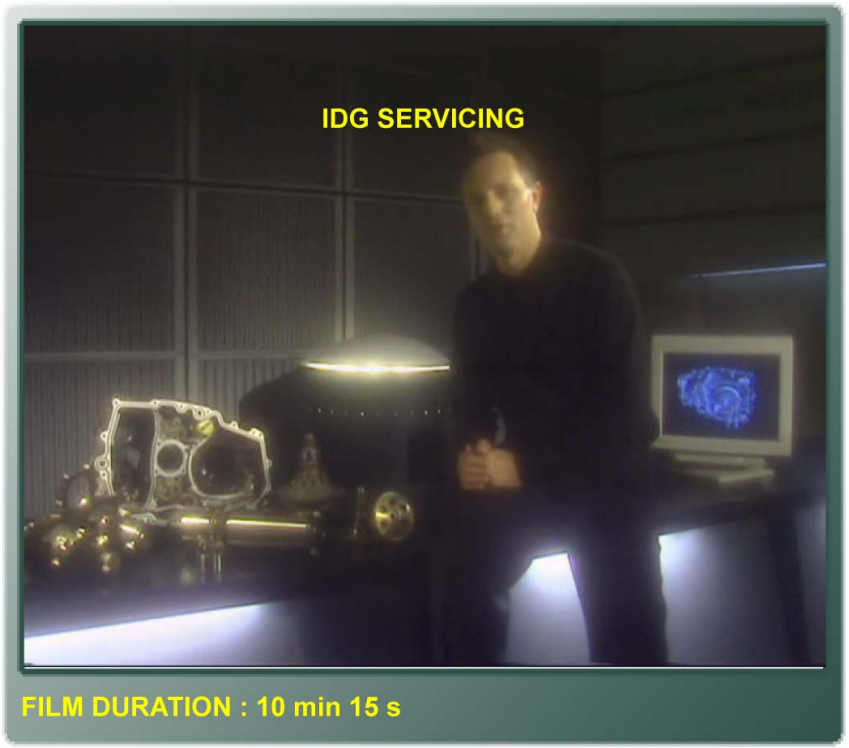
IDG oil level visual inspection



235 VU

IDG SERVICING - FILLING OF THE IDG WITH OIL OR ADDITION OF OIL AFTER A LEVEL CHECK - IDG OIL LEVEL INSPECTION



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IDG SERVICING - FILLING OF THE IDG WITH OIL OR ADDITION OF OIL AFTER A LEVEL CHECK - IDG OIL LEVEL INSPECTION

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ELECTRICAL POWER LINE MAINTENANCE BRIEFING (2)

OPERATIONAL TEST OF THE IDG DISCONNECT AND RECONNECT FUNCTION

The IDG will be disconnected in case of:
- oil overheat (high oil out temperature),
- oil pressure drop when not caused by drive under speed.

The amber fault legend of the ELECtrical/IDG P/BSWs comes on, and the master caution is triggered. In this case, the related IDG should be manually disconnected. For this, push to disconnect the IDG safety guarded P/BSW installed on the panel 235 VU.

CAUTION: ENGAGE THE IDG DISCONNECT MECHANISM WITH THE DISCONNECT RESET RING BEFORE YOU START THE ENGINE. IF NOT, YOU WILL CAUSE DAMAGE TO THE GEAR TEETH, AT ENGINE START.
YOU CAN DAMAGE THE DISCONNECT SOLENOID BECAUSE OF OVERHEATING IF: YOU PUSH THE IDG DISCONNECT P/BSW FOR MORE THAN 3 SECONDS.
THERE MUST BE AT LEAST 60 SECONDS BETWEEN 2 OPERATIONS OF THE SWITCH.

On the ELEC control panel, push the related IDG P/BSW.
On the IDG slowly pull out the disconnect reset ring to the full limit of travel. If you feel a click while you hold the disconnect reset ring, this shows that the disconnect function operates correctly. Let the disconnect reset ring go slowly back to the initial position.

NOTE: The IDG disconnection is irreversible in flight. Reconnection of the system is then possible only on the ground with engines shut down.
There are two different AMM tasks for the operational test of the IDG disconnect and reconnect (reset) function, depending on whether the engine is stopped or in operation.

The procedure is identical on the A330.

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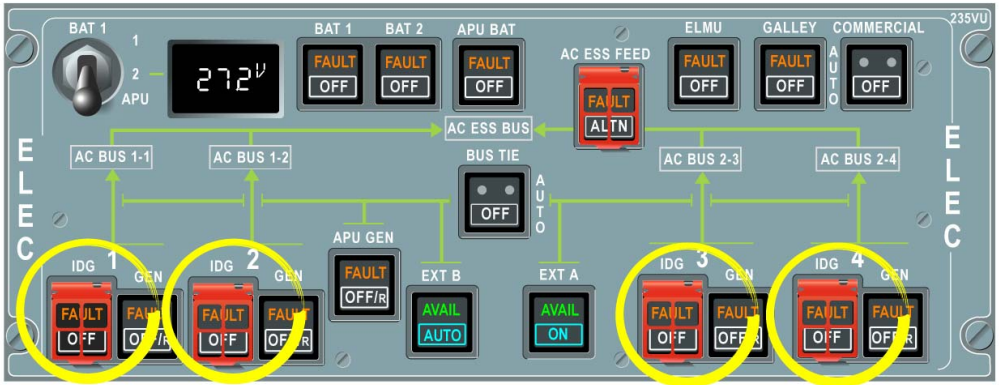
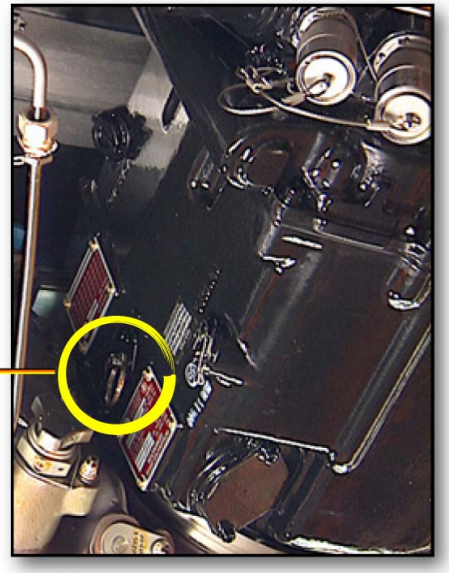


A340 ELECTRICAL CONTROL PANEL

CFM56



DISCONNECT RESET RING

INTEGRATED DRIVE GENERATOR (IDG)

CAUTION

ENGAGE THE IDG DISCONNECT MECHANISM WITH THE DISCONNECT RESET RING BEFORE YOU START THE ENGINE. IF NOT, YOU WILL CAUSE DAMAGE TO THE GEAR TEETH, AT ENGINE START.

CAUTION

YOU CAN DAMAGE THE DISCONNECT SOLENOID BECAUSE OF OVERHEATING IF:
YOU PUSH THE IDG DISCONNECT P/BSW FOR MORE THAN 3 SECONDS.
THERE MUST BE AT LEAST 60 SECONDS BETWEEN 2 OPERATIONS OF THE SWITCH.

This procedure is described for training only, use the relevant AMM task as a reference.

OPERATIONAL TEST OF THE IDG DISCONNECT AND RECONNECT FUNCTION

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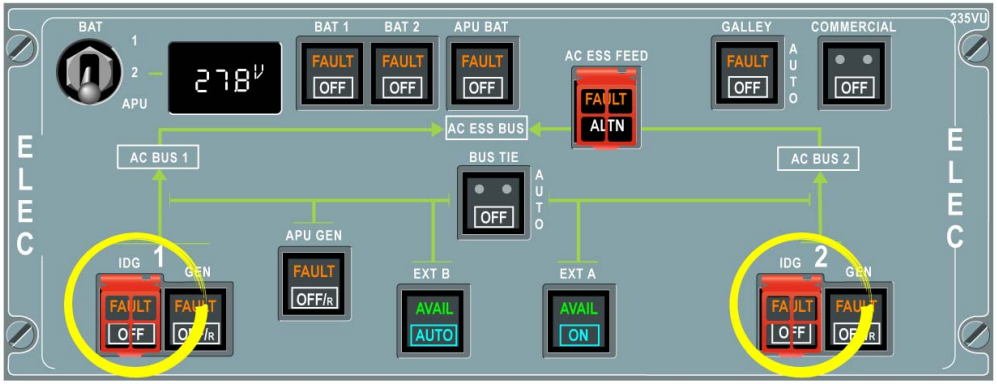


A330 ELECTRICAL CONTROL PANEL

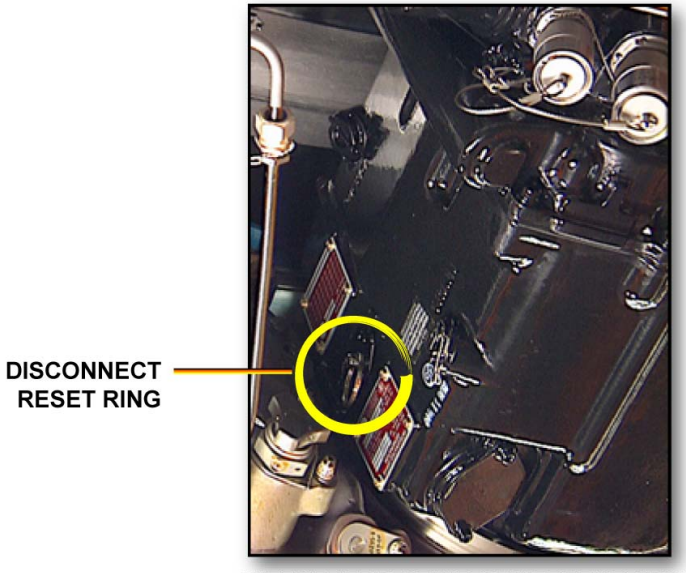
CAUTION

ENGAGE THE IDG DISCONNECT MECHANISM WITH THE DISCONNECT RESET RING BEFORE YOU START THE ENGINE. IF NOT, YOU WILL CAUSE DAMAGE TO THE GEAR TEETH, AT ENGINE START.

CAUTION

YOU CAN DAMAGE THE DISCONNECT SOLENOID BECAUSE OF OVERHEATING IF:
YOU PUSH THE IDG DISCONNECT P/BSW FOR MORE THAN 3 SECONDS.
THERE MUST BE AT LEAST 60 SECONDS BETWEEN 2 OPERATIONS OF THE SWITCH.

This procedure is described for training only, use the relevant AMM task as a reference.



INTEGRATED DRIVE GENERATOR (IDG)

OPERATIONAL TEST OF THE IDG DISCONNECT AND RECONNECT FUNCTION

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ELECTRICAL POWER LINE MAINTENANCE BRIEFING (2)

COLD WEATHER MAINTENANCE FOR BATTERIES

This procedure gives the maintenance practices for the batteries when the A/C is in cold soak configuration.

GENERAL

In very low temperatures, the chemical reaction of the electrolyte is slower and the performance of the batteries decreases:
- the high current supply from the batteries decreases,
- the necessary time to charge the batteries increases.

This procedure gives instructions that keep the batteries serviceable.

NOTE: The values specified in this procedure are only applicable if the A/C doors remain closed during the cold soak.

G9409341 - GAUT0T0 - FM24B1000000001

Cold weather maintenance for batteries

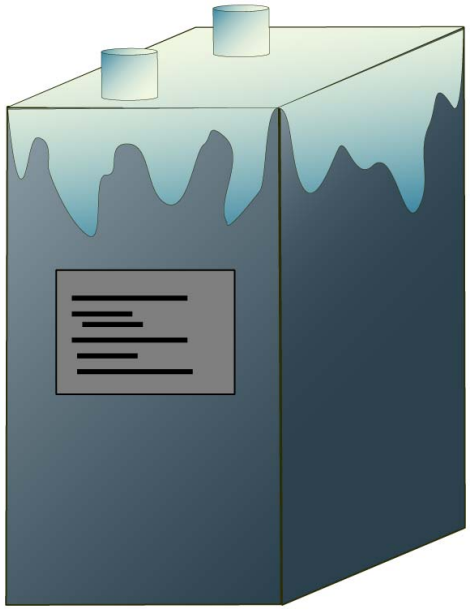
In very low temperatures, the chemical reaction of the electrolyte is slower and the performance of the batteries decreases:

- the high current supply from the batteries decreases,

- the necessary time to charge the batteries increases.

This procedure is described for training only, use the relevant AMM task as a reference.

The values specified in this procedure are only applicable if the aircraft doors remain closed during the cold soak.



COLD WEATHER MAINTENANCE FOR BATTERIES - GENERAL

ELECTRICAL POWER LINE MAINTENANCE BRIEFING (2)

COLD WEATHER MAINTENANCE FOR BATTERIES (continued)

BATTERY COLD WEATHER MAINTENANCE PRACTICES

The batteries can stay on the A/C if:
- the Outside Air Temperature (OAT) stays higher than -15 °C (+5.00 °F),
- the OAT is approximately -15 °C (+5.00 °F) for not more than 12 hours,
- the OAT is between -15 °C (+5.00 °F) and -30 °C (-22.00 °F) for not more than 6 hours.

You must remove the 3 batteries if the OAT is lower than -30 °C (-22.00 °F).
You must respect the temperature limit, otherwise you can decrease the life of batteries, or you can damage them.

NOTE: We recommend that you use a Ground Power Unit (GPU) to start the APU if the OAT was lower than -15 °C (+5.00 °F).

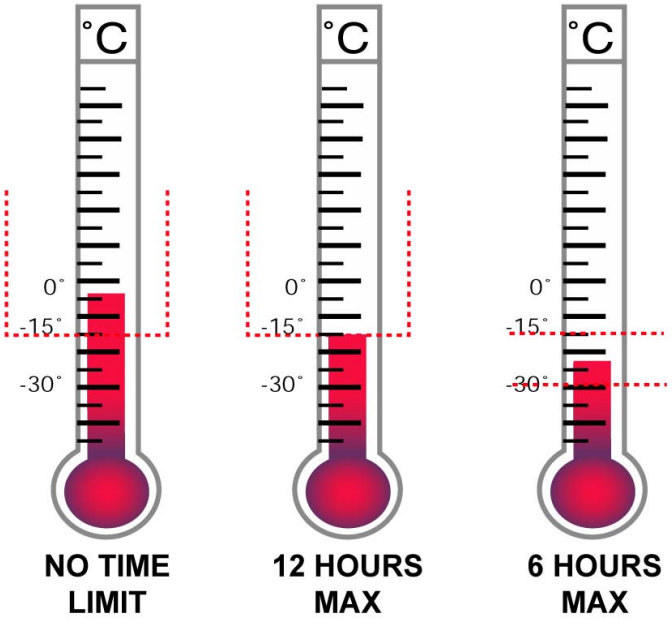
G9409341 - GAUT0T0 - FM24B1000000001

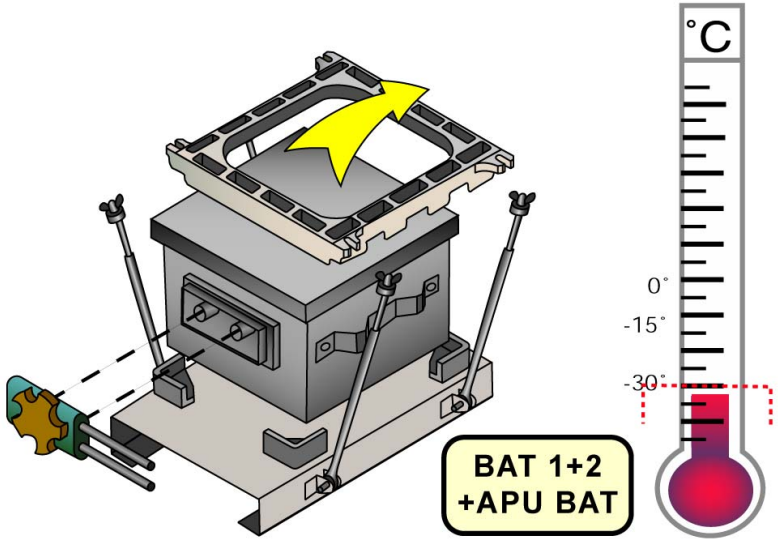
Cold weather maintenance for batteries

Batteries cold weather maintenance practices

The batteries can stay on the aircraft during the cold soak if:
- the Outside Air Temperature (OAT) stays higher than -15 °C (+5.00 °F),
- the OAT is approximately -15 °C (+5.00 °F) for not more than 12 hours,
- the OAT is between -15 °C (+5.00 °F) and -30 °C (-22.00 °F) for not more than 6 hours.

If the OAT is lower than -30 °C (-22.00 °F), remove the 3 batteries.





COLD WEATHER MAINTENANCE FOR BATTERIES - BATTERY COLD WEATHER MAINTENANCE PRACTICES

G9409341 - GAUT0T0 - FM24B1000000001

Cold weather maintenance for batteries

GROUND POWER UNIT (GPU)

We recommend that you use a GPU to start the APU if the OAT was lower than -15 deg.C (+5.00 deg.F) during the cold soak.

COLD WEATHER MAINTENANCE FOR BATTERIES - BATTERY COLD WEATHER MAINTENANCE PRACTICES

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ELECTRICAL SYSTEM GENERAL DESCRIPTION (3)

ELECTRICAL GENERATION

The electrical power system supplies Alternating Current (AC) and Direct Current (DC) to power the aircraft electrical network.
The AC main power sources are:
- two Integrated Drive Generators (IDGs),
- Auxiliary Power Unit (APU) GENerator,
- the two external power sources A and B.

The AC emergency power sources are:
- the EMERgency GENerator,
- and the STATic INVerter supplied by the aircraft batteries. The DC main power sources are three Transformers Rectifiers (TRs) supplied by the AC system. The DC emergency power sources are the two aircraft BATteries. A third battery, the APU BATtery, related to the APU TR, is only used in starting the APU.

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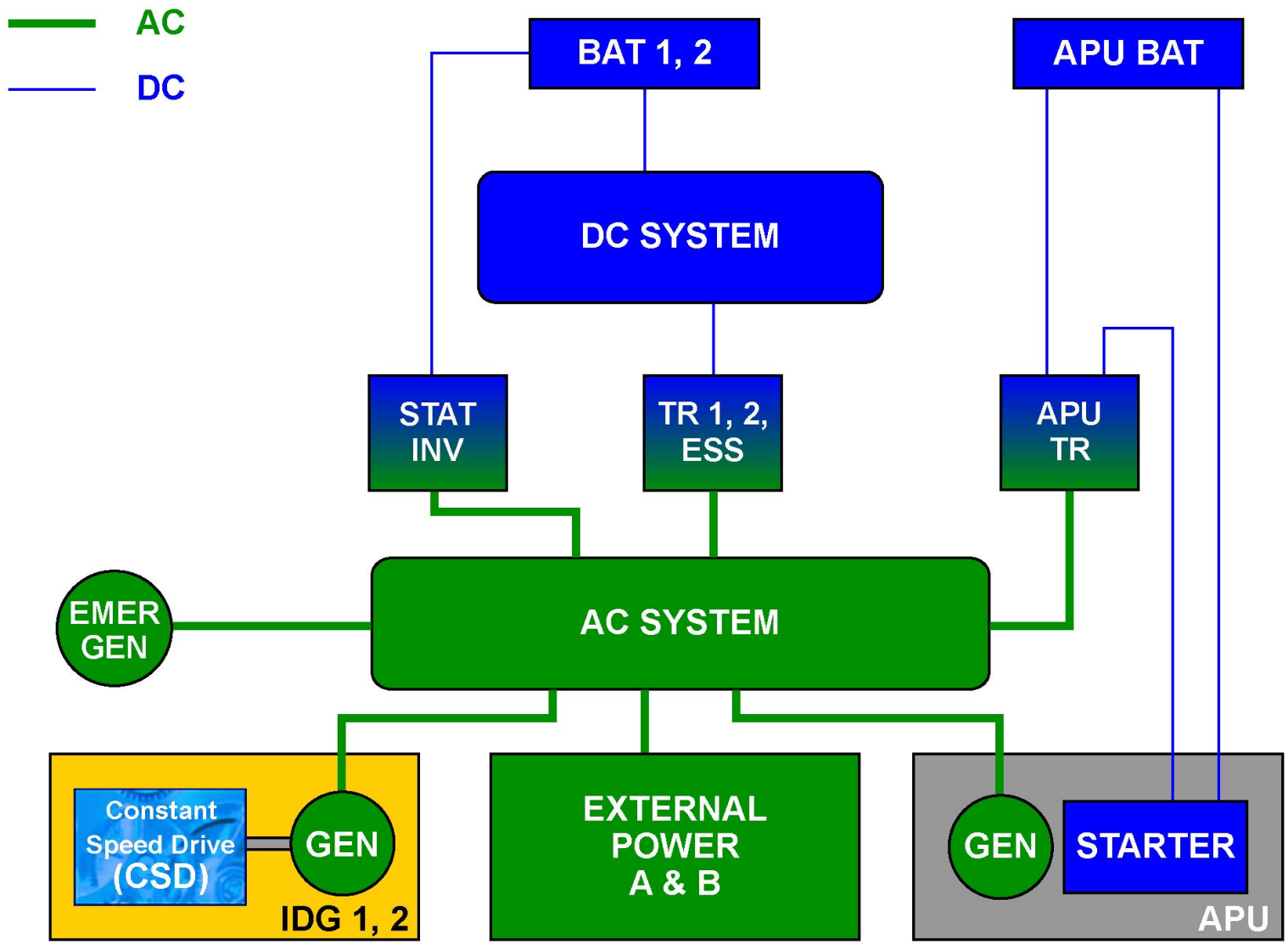

ELECTRICAL GENERATION

G9409341 - GAUT0T0 - FM24DC000000002

ELECTRICAL SYSTEM GENERAL DESCRIPTION (3)

AC MAIN GENERATION

The main generators (IDGs) supply the electrical network through a Generator Line Contactor (GLC). The APU generator can supply the electrical network through an APU Generator Line Contactor (APU GLC). Each external power can supply the electrical network through an External Power Contactor (EPC).

AC TRANSFER

The AC transfer circuit comprises two Bus Tie Contactors (BTCs) and a System Isolation Contactor (SIC). These contactors operate automatically in order to supply the main busbars in different configurations depending on the AC sources available.

AC EMERGENCY GENERATION

The EMERgency GENerator, also called Constant Speed Motor/Generator (CSM/G) is used in emergency electrical configuration; when the main AC BUSES are lost. The CSM/G can supply the electrical network through an EMERgency Generator Line Contactor (EMER GLC). The CSM/G is a hydraulic-driven generator supplied by the green hydraulic system. The STAT INV is supplied from the aircraft batteries 1 and 2, and automatically supplies the AC ESSential BUS if no other AC sources or EMER GEN are available.

AC ESSENTIAL SUPPLY

In normal configuration, the AC ESS BUS is supplied from AC BUS 1. If AC BUS 1 fails, there is an automatic switching of the supply to AC BUS 2. The AC ESS BUS switching can also be done manually in the flight deck. Other sources of supply for the AC ESS BUS are the EMER GEN, or the STAT INV.

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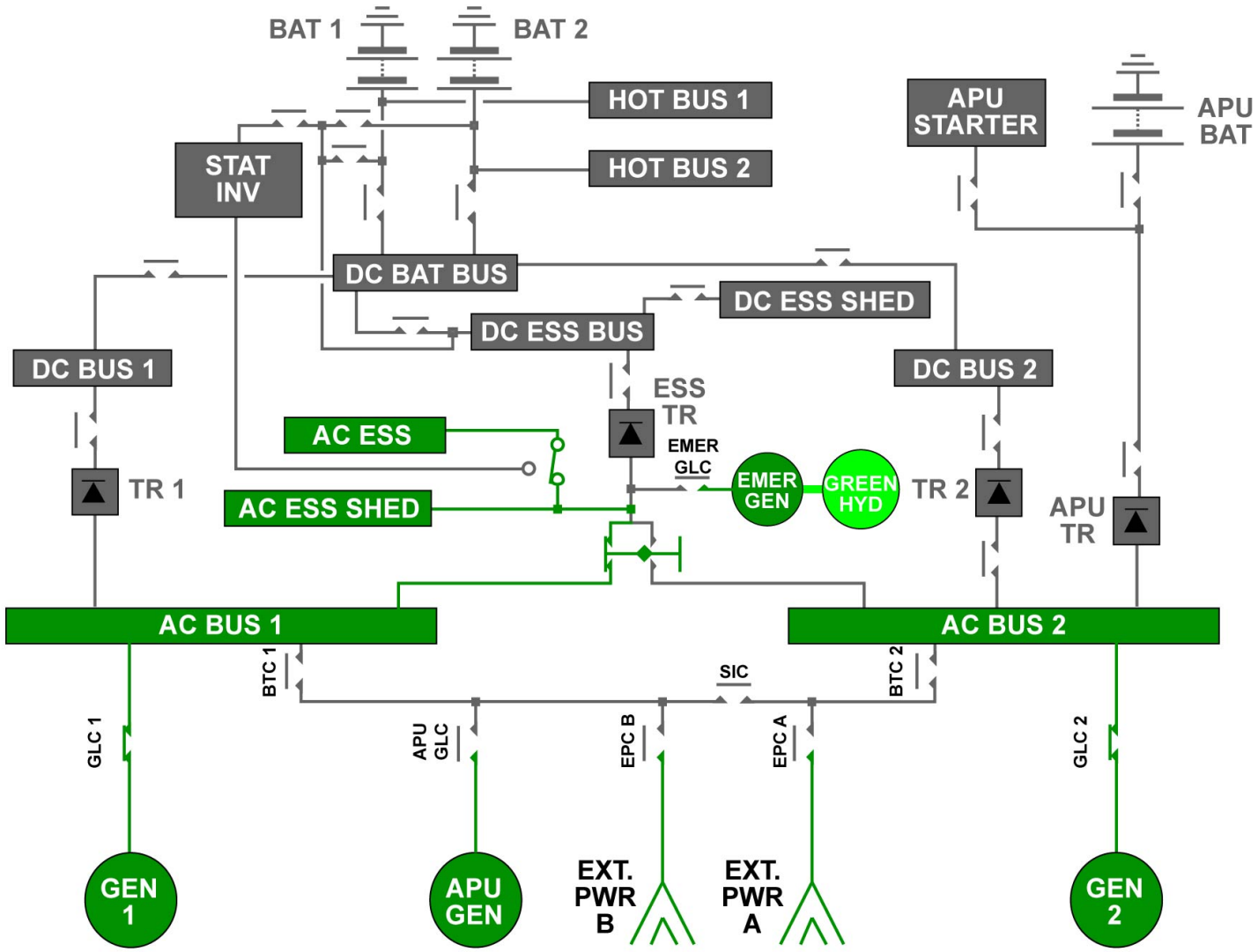

AC MAIN GENERATION - AC TRANSFER ... AC ESSENTIAL SUPPLY

G9409341 - GAUT0T0 - FM24DC000000002

ELECTRICAL SYSTEM GENERAL DESCRIPTION (3)

AC MAIN GENERATION (continued)

AC GENERATION PROPERTIES

This table gives the properties of the different AC power sources.
Note that the static inverter is a single-phase power source.

G9409341 - GAUT0T0 - FM24DC000000002

	POWER	VOLTAGE	FREQUENCY	PHASES
IDG	115 KVA	115 V	400 Hz	3
APU GENERATOR	115 KVA	115 V	400 Hz	3
EXTERNAL POWER	90 KVA	115 V	400 Hz	3
CSM/G	8 KVA	115 V	400 Hz	3
STATIC INVERTER	2.5 KVA	115 V	400 Hz	1

G9409341 - GAUT0T0 - FM24DC000000002

AC MAIN GENERATION - AC GENERATION PROPERTIES

ELECTRICAL SYSTEM GENERAL DESCRIPTION (3)

DC MAIN GENERATION

The DC main system is composed of 4 buses:
- DC BUS 1 supplied from AC BUS 1 via TR 1,
- DC BUS 2 supplied from AC BUS via TR 2,
- the DC BAT BUS is normally supplied from DC BUS 1. The DC BAT BUS can also be supplied from DC BUS 2 in some failure configurations.

DC ESSENTIAL SUPPLY

The ESS TR normally supplies the DC ESS BUS from AC BUS 1 or AC BUS 2 when AC BUS 1 is lost.

BAT 1, 2 AND APU BAT

With the loss of all AC power sources including the EMER GEN, BAT 1 and 2 supply the DC ESS BUS. The aircraft BAT HOT BUSES are always supplied from the batteries. The APU BAT is used to start the APU.

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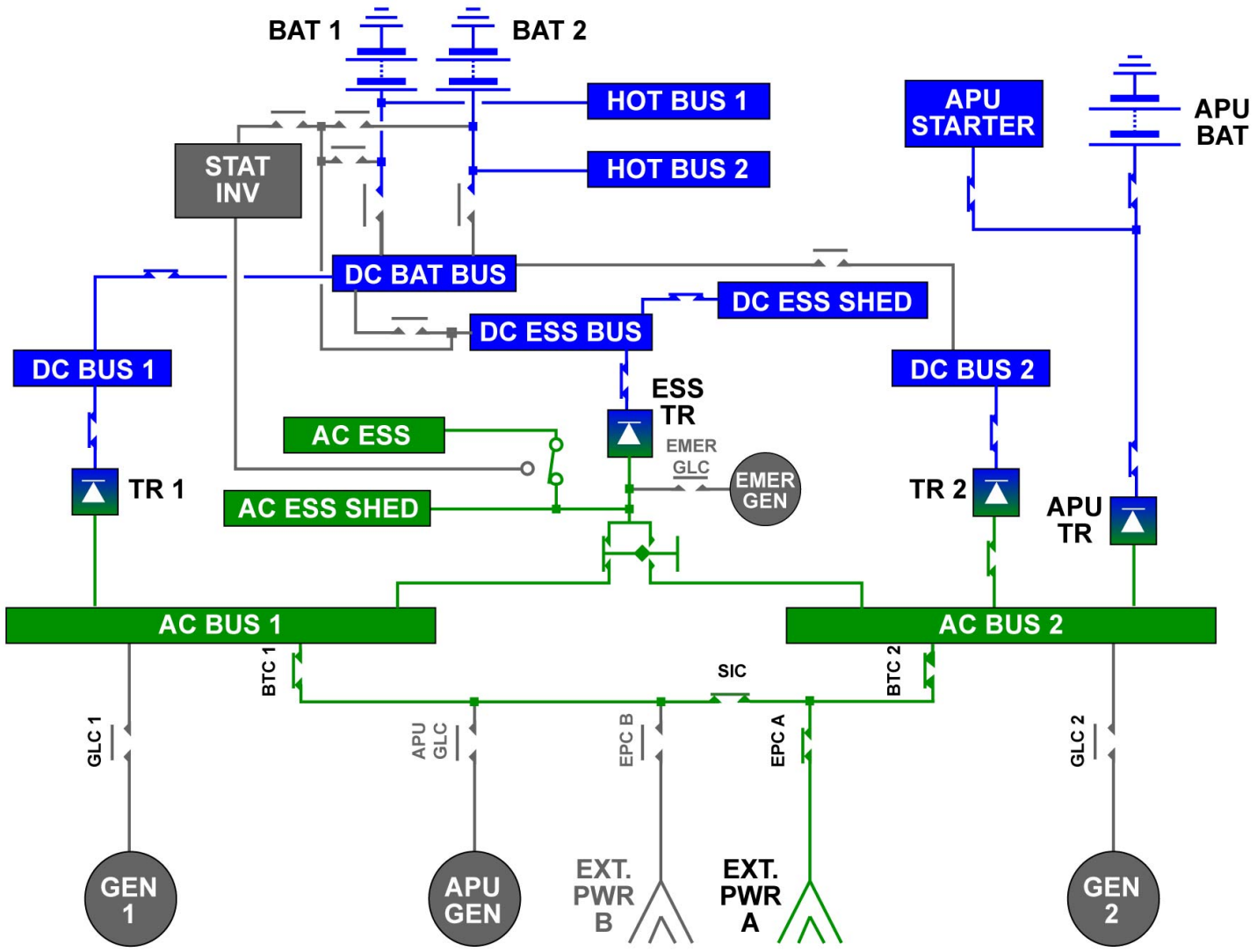

DC MAIN GENERATION - DC ESSENTIAL SUPPLY & BAT 1, 2 AND APU BAT

G9409341 - GAUT0T0 - FM24DC000000002

ELECTRICAL SYSTEM GENERAL DESCRIPTION (3)

DC MAIN GENERATION (continued)

SERVICE BUSES

The AC and DC SERVICES BUSES can only supply limited items for the servicing of the aircraft (cabin cleaning, cargo loading, ..). This is done to not supply the entire electrical network of the aircraft. This ground service supply is done via a direct connection from EXT PWR A only. The MAINTenance BUS switch (in the cabin forward entry area - C/B panel 5001VE) must be selected ON and EXT PWR A available, in order to supply the service buses.

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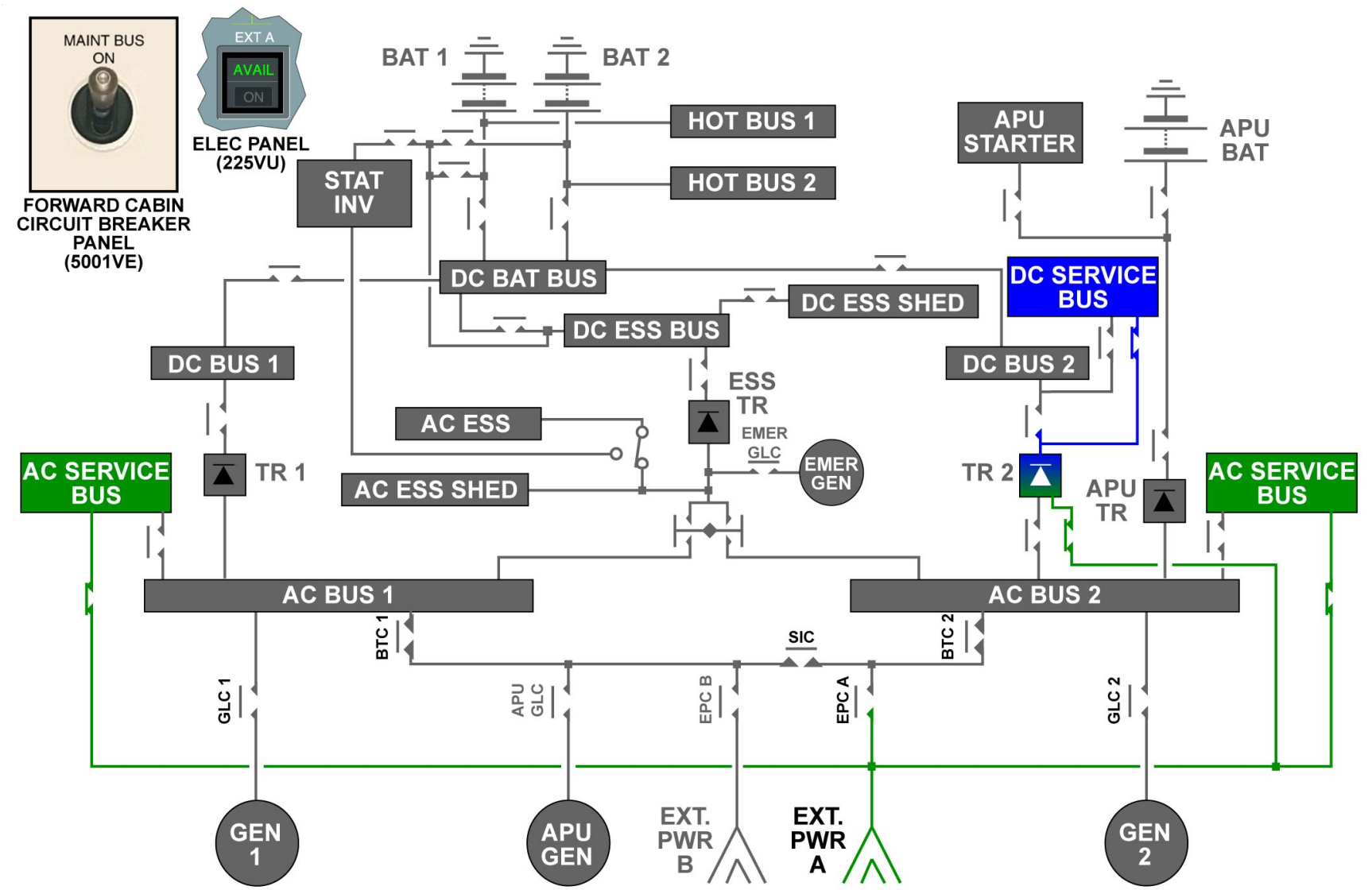

DC MAIN GENERATION - SERVICE BUSES

ELECTRICAL SYSTEM GENERAL DESCRIPTION (3)

NORMAL CONFIGURATION

This figure shows a normal configuration on ground, with EXT PWR A only. The BTCs and the SIC operate automatically. If EXT PWR B is made available and selected ON, the SIC would automatically open and allow EXT PWR B to supply the left side of the network.

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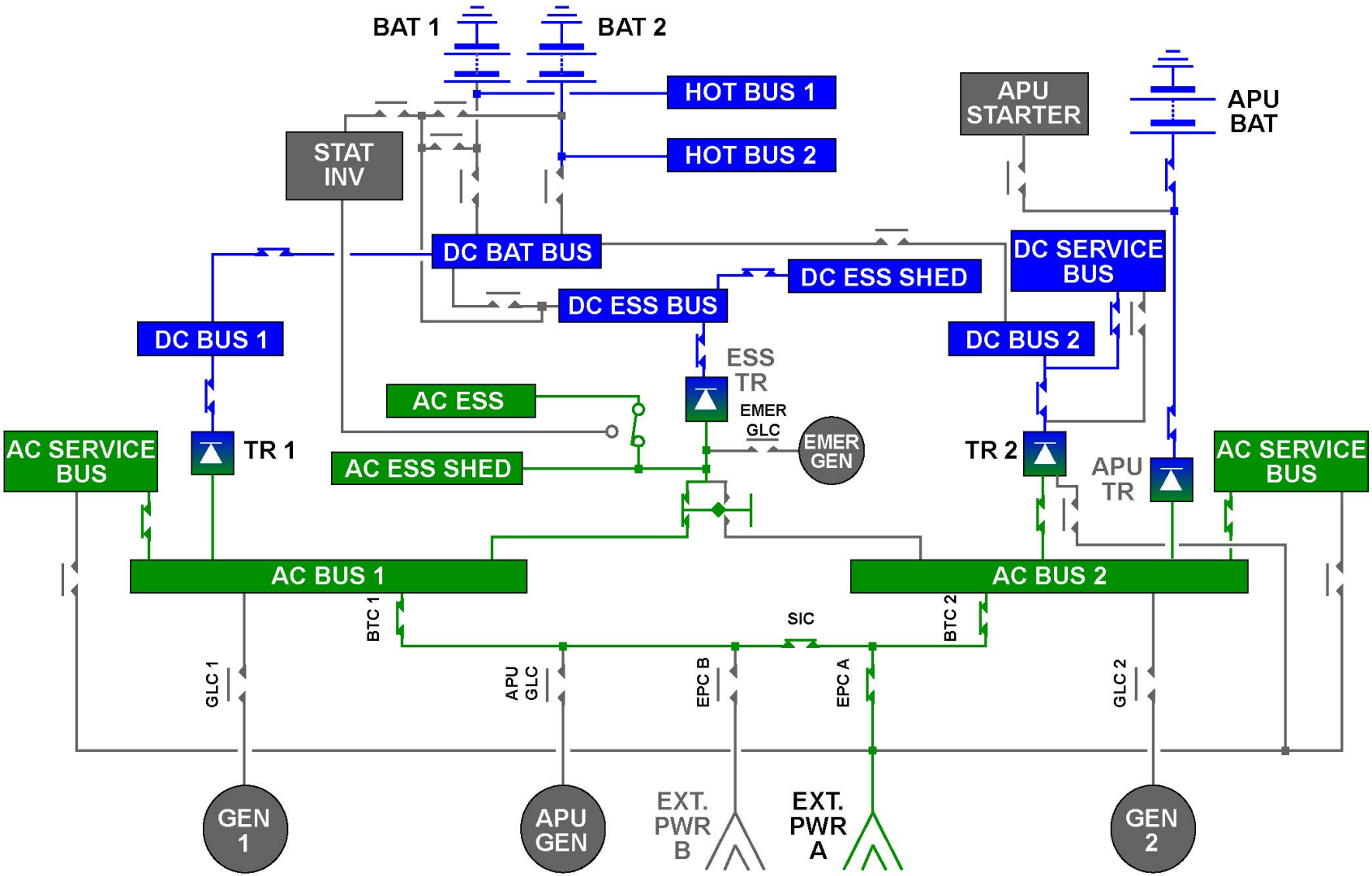

NORMAL CONFIGURATION

G9409341 - GAUT0T0 - FM24DC000000002

ELECTRICAL SYSTEM GENERAL DESCRIPTION (3)

NBPT FUNCTION

When the APU is started and the APU GEN is available, the APU GEN will automatically take over the supply of the LH side of the network. Here, the APU GEN supplies the left side (priority over the EXT PWR B) while EXT PWR A supplies the RH side. Note that, on ground only, during AC power source transfers, the AC power sources are momentarily connected in parallel for a short period of time. This function is called No Break Power Transfer (NBPT). The NBPT operates only on ground, and during start and shutdown of the engine generators, the APU GEN and the EXT PWR. The NBPT function prevents power transients on the aircraft electrical network when switching AC power sources on the ground. The NBPT function and operation is fully explained in the "CONTACTOR MANAGEMENT DESCRIPTION and OPERATION" module.

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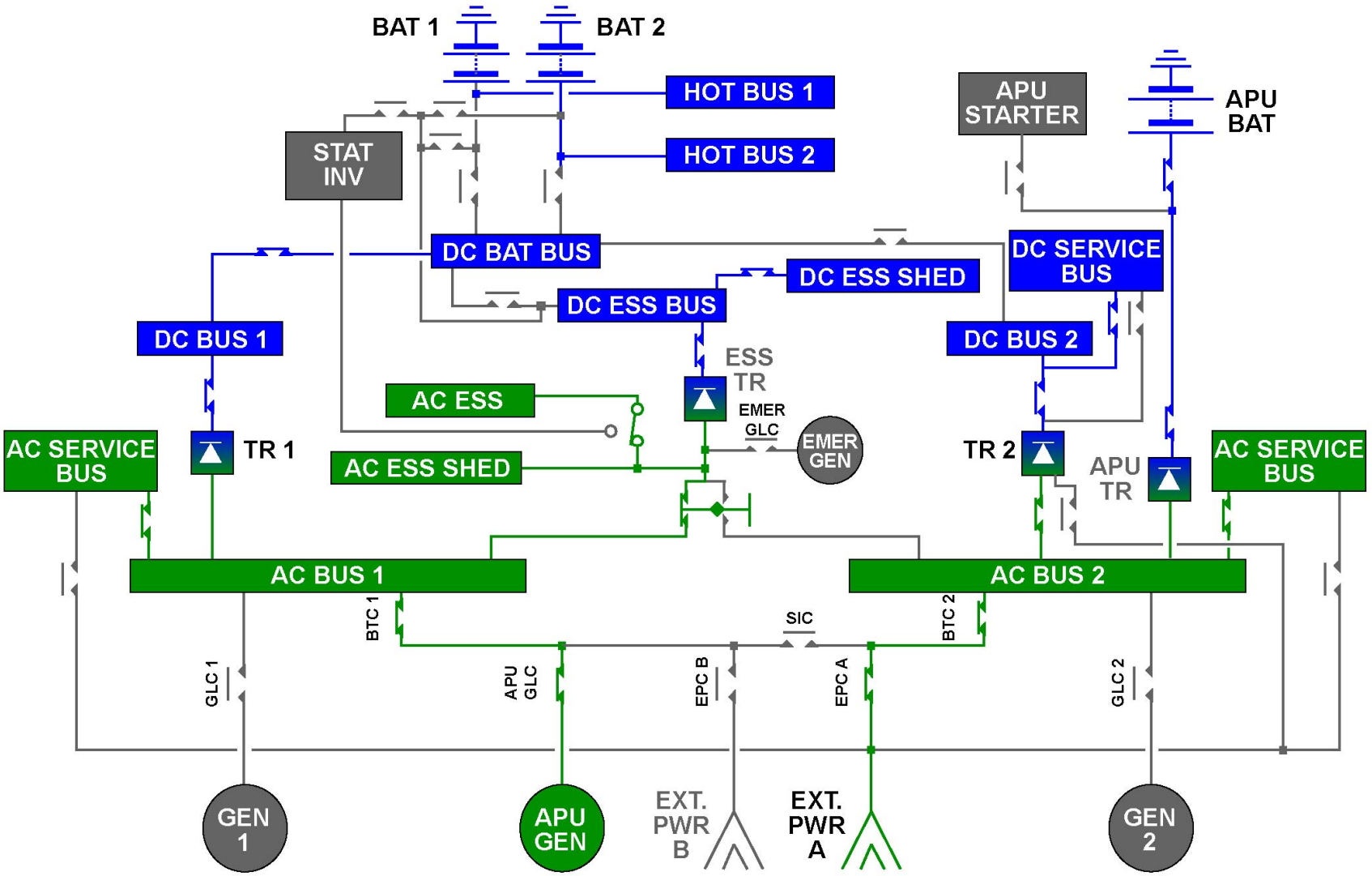

NBPT FUNCTION

G9409341 - GAUT0T0 - FM24DC000000002

ELECTRICAL SYSTEM GENERAL DESCRIPTION (3)

SUPPLY PRIORITY

In normal configuration, each engine generator supplies independently its own AC busbar. This is a split bus system.
The AC power source supply priority for each main AC BUS is as follows:
- for AC BUS 1: GEN 1 / APU GEN / EXT B / EXT A / GEN 2,
- for AC BUS 2: GEN 2 / EXT A / APU GEN / EXT B / GEN 1.

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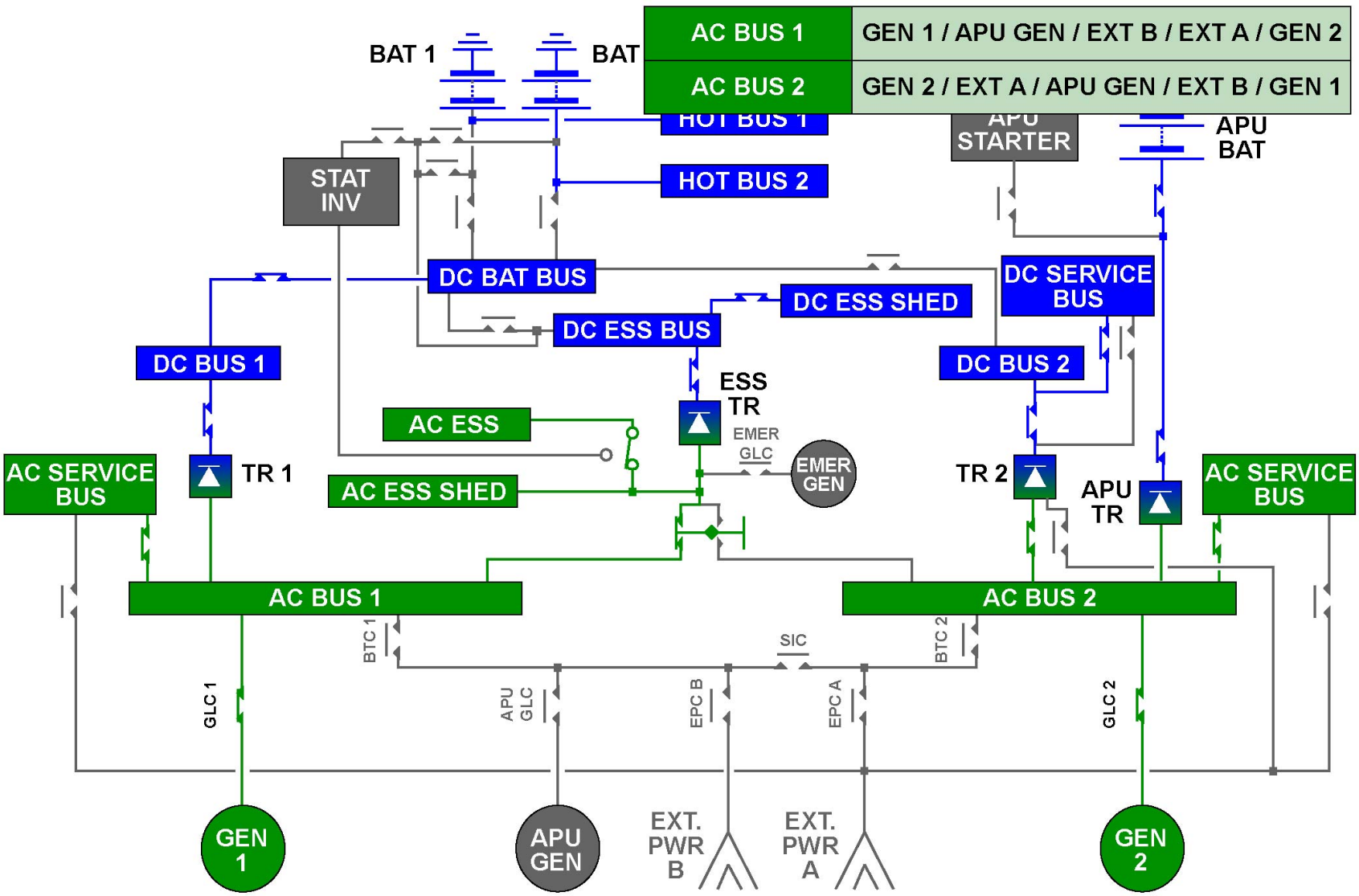

SUPPLY PRIORITY

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ELECTRICAL SYSTEM GENERAL DESCRIPTION (3)

EMERGENCY CONFIGURATION

If AC BUS 1 and AC BUS 2 are lost, there is an automatic start of the EMER GEN (or CSM/G). This start sequence takes approximately 7 to 10 seconds. During approximately 7 to 10 seconds, the aircraft batteries supply the AC ESS BUS and the DC ESS BUS . When the EMER GEN is available the EMER GEN supplies the AC ESS BUS and the DC ESS BUS through the ESS TR. The EMER GEN will supply the AC and DC ESS buses until the end of the flight. The function and operation of the EMER GEN (CSM/G) is fully explained in the "EMERGENCY AC GENERATION SYSTEM DESCRIPTION and OPERATION" module.

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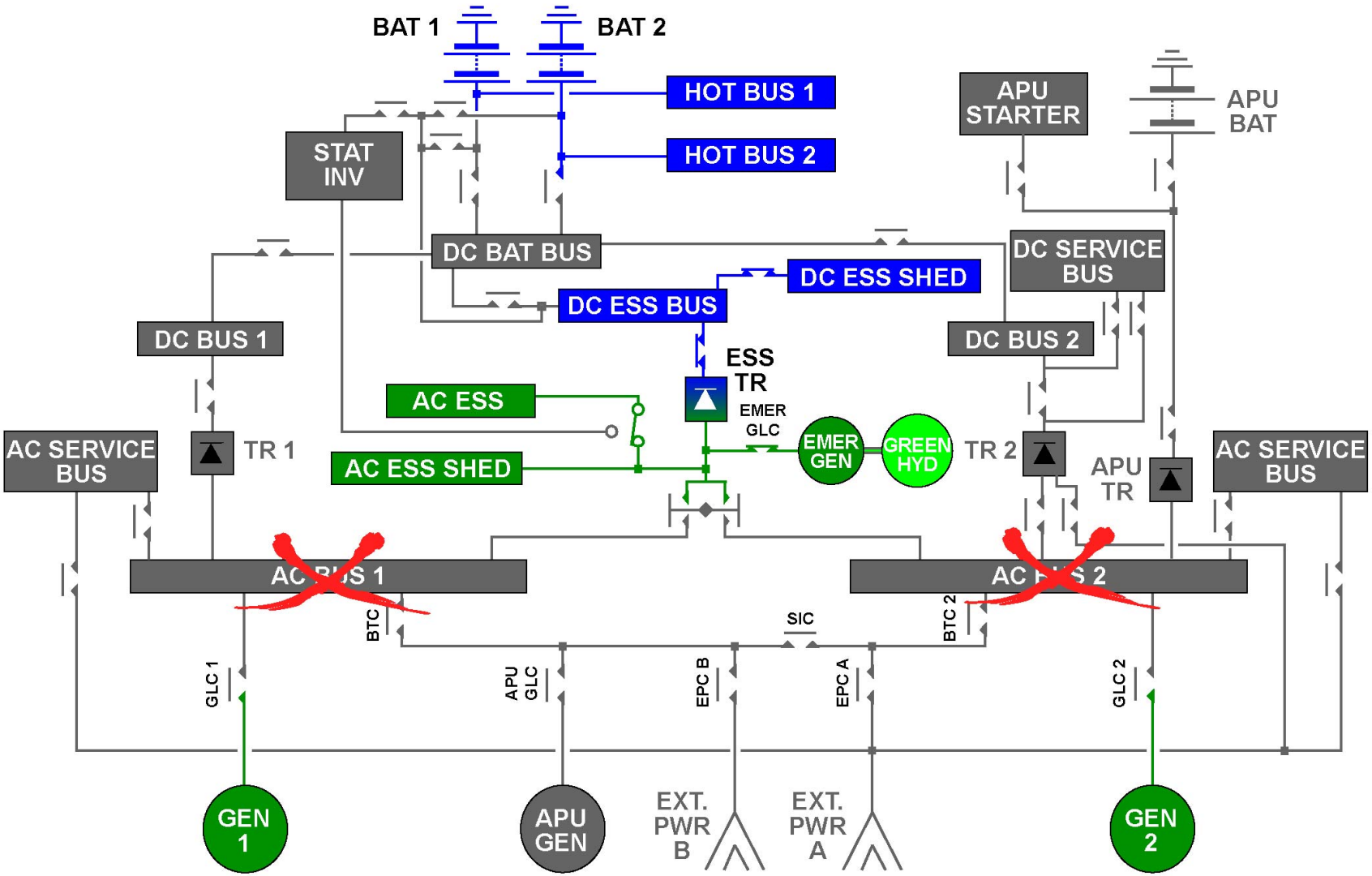

EMERGENCY CONFIGURATION

G9409341 - GAUT0T0 - FM24DC000000002

ELECTRICAL SYSTEM GENERAL DESCRIPTION (3)

BATTERIES ONLY SUPPLY

Fully charged aircraft batteries can supply the aircraft in flight or on ground in case of total loss of electrical sources.

IN-FLIGHT

Fully charged aircraft batteries can supply the aircraft in flight (speed above 50 Kts) for a minimum of 30 minutes. Note that batteries are connected in parallel and supply the DC ESS BUS and the AC ESS BUS via the STAT INV. In order to reduce the load on the aircraft batteries, the AC ESS SHED and DC ESS SHED buses are shed.

ON GROUND

This figure shows the electrical network configuration when batteries are the only supply on the aircraft on the ground. There is a complete discharge protection for the aircraft batteries. Note that batteries are connected in parallel and supply the DC ESS BUS, DC BAT BUS and the AC ESS BUS via the STAT INV. In order to reduce the load on the aircraft batteries, the AC ESS SHED and DC ESS SHED buses are shed.

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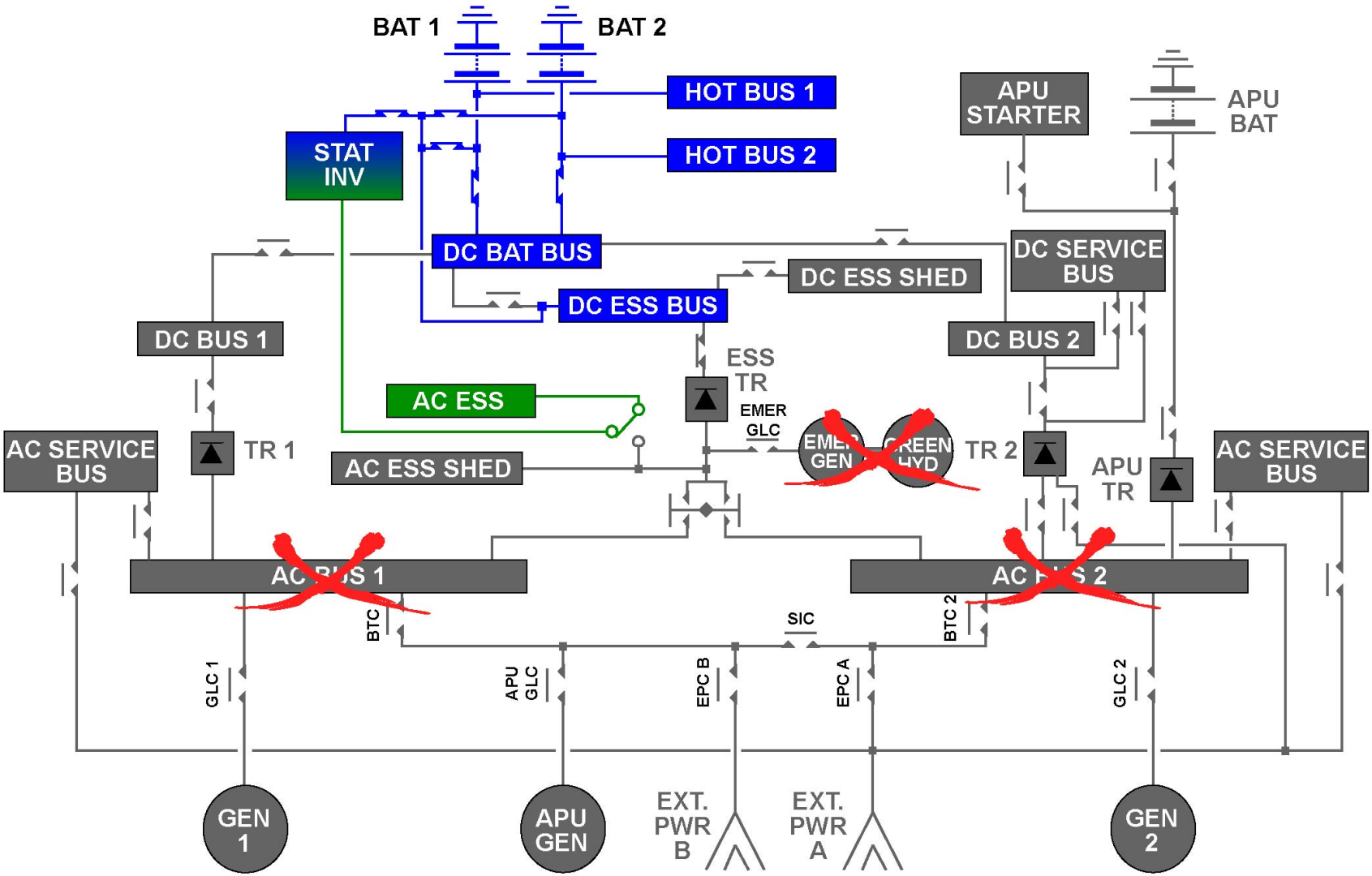

BATTERIES ONLY SUPPLY - IN-FLIGHT & ON GROUND

G9409341 - GAUT0T0 - FM24DC000000002

ELECTRICAL SYSTEM GENERAL DESCRIPTION (3)

CONTROL AND MANAGEMENT

In order to control, protect and manage all power sources and the electrical network, several computers are involved in the electrical system.

GENERATOR CONTROL UNIT (GCU)

Two identical Generator Control Units (GCUs) control, monitor and protect the engine IDGs.

GROUND AND AUXILIARY POWER CONTROL UNIT (GAPCU)

The Ground and Auxiliary Power Control Unit (GAPCU) controls, monitors and protects the two external power sources A and B and the APU GEN. It is also an interface for the GCUs BITE and for the Central Maintenance System (CMS).

ELECTRICAL CONTACTOR MANAGEMENT UNIT (ECMU)

Two Electrical Contactor Management Units (ECMUs) control the main AC and DC electrical power contactors, to manage the power source priorities, which enable the reconfiguration of the main power supply sources. In addition, the ECMUs also authorize and supervise the NBPT function between available power sources and manage the galley shedding function to prevent a sustained overload condition on the AC power sources.

CONSTANT SPEED MOTOR / GENERATOR GCU (CSM/G GCU)

One CSM/G GCU controls, monitors and protects the CSM/G (EMER GEN).

BATTERY CHARGE LIMITER (BCL)

Three identical and interchangeable Battery Charge Limiters (BCLs) control, monitor and protect the batteries.

CIRCUIT BREAKER MONITORING UNIT (CBMU)

One Circuit Breaker Monitoring Unit (CBMU) is installed in order to monitor the status of the C/Bs.

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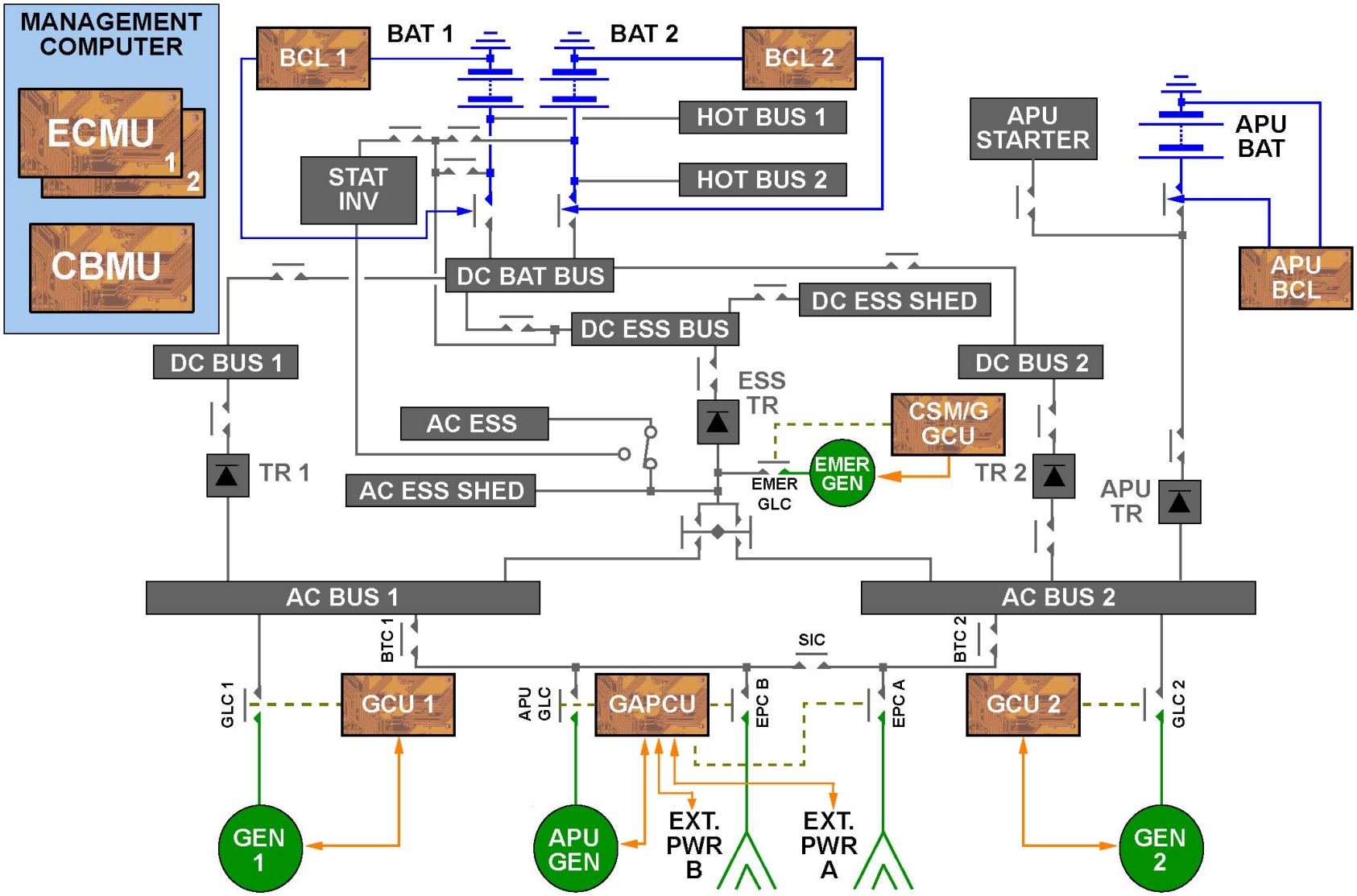

CONTROL AND MANAGEMENT - GENERATOR CONTROL UNIT (GCU) ... CIRCUIT BREAKER MONITORING UNIT (CBMU)

MAIN AC GENERATION D/O (3)

PRESENTATION

This module shows the Integrated Drive Generator (IDG) control, indicating and operation.

ELECTRICAL PANEL AND AC ECAM PAGE

On the overhead panel, on the ELECtrical panel (235VU), it is possible to control and monitor:
- the IDG disconnection via IDG P/B,
- the GENerator disconnection and Generator Control Unit (GCU) resetting via GEN P/B.

The EL/AC ECAM page allows the monitoring of IDG. For this explanation, IDG 1 is used as an example.

INTEGRATED DRIVE GENERATOR

There is one IDG for each engine. IDGs are identical and each IDG supplies its own AC busbar.
IDG is a two-pole high speed (24000 RPM) brushless spray oil cooled unit.
IDG comprises, in a common housing:
- the drive part, called Constant Speed Drive (CSD), containing monitoring and control components,
- the GENerator part, composed of a Permanent Magnetic Generator (PMG), an exciter generator with rotating diodes and a main GEN.

The CSD of the IDG converts the variable input speed (4900 to 9120 RPM), provided by the engine gearbox, into a constant output speed (24000 RPM).

GENERATOR CONTROL UNIT

Each IDG is controlled and monitored by its own GCU. All the GCUs are fully identical and interchangeable. The GCU does the following main functions:
- control, monitoring and protection of the IDG (GEN and CSD),
- regulation of the GEN voltage,
- regulation of the GEN frequency,
- No Break Power Transfer (NBPT) function in conjunction with the Electrical Contactor Management Units (ECMUs),
- interface with the System Data Acquisition Concentrators (SDACs) for indication,
- interface with the Full Authority Digital Engine Control (FADEC) for engine speed acquisition for control, monitoring and protection functions,
- interface with the Central Maintenance System (CMS) via the Ground and Auxiliary Power Control Unit (GAPCU) for BITE functions.

A pin programming gives to the GCU the following information:
- the A/C type,
- the GCU position identification,
- the current limit for voltage regulation.

During normal operation, each GCU performs voltage and frequency monitoring and regulation. The GCU provides operational indications to the flight deck and protects the IDG from abnormal operation.

GENERATOR LINE CONTACTOR

The Generator Line Contactor (GLC) lets connect the generator to the related AC BUSbar. Each GLC is controlled and monitored by the related GCU and ECMU.

FEEDER LINE

A 3-phase generator feeder cable and neutral connects the generator terminal block to a terminal block installed on the upper engine structure (disconnection for engine change). The neutral line is grounded to the engine structure. Another terminal block, installed in the pylon, splits each phase into two feeder cables (parallel feeders), sent through the wing leading edges and the cargo compartment to rack 710VU in the avionics compartment. The parallel feeders are connected to the GLC after going through a 6-hole Current Transformer (CT) used for protection monitoring. The feeder lines

G9409341 - GAUT0T0 - FM24D1000000003

and the GEN are monitored and protected for differential current conditions and open cable conditions.

ECMU

The GLC is under control of the related GCU and ECMU. If all parameters are correct, the GLC connects the generator to its own busbar.
The ECMUs receive relative IDG information via the GCUs. Each ECMU monitors the status of its own side contactors (ECMU 1 for LH side and ECMU 2 for RH side) and ensures the opening or closing of the contactors according to the priority logic and the NBPT operation (on ground only).

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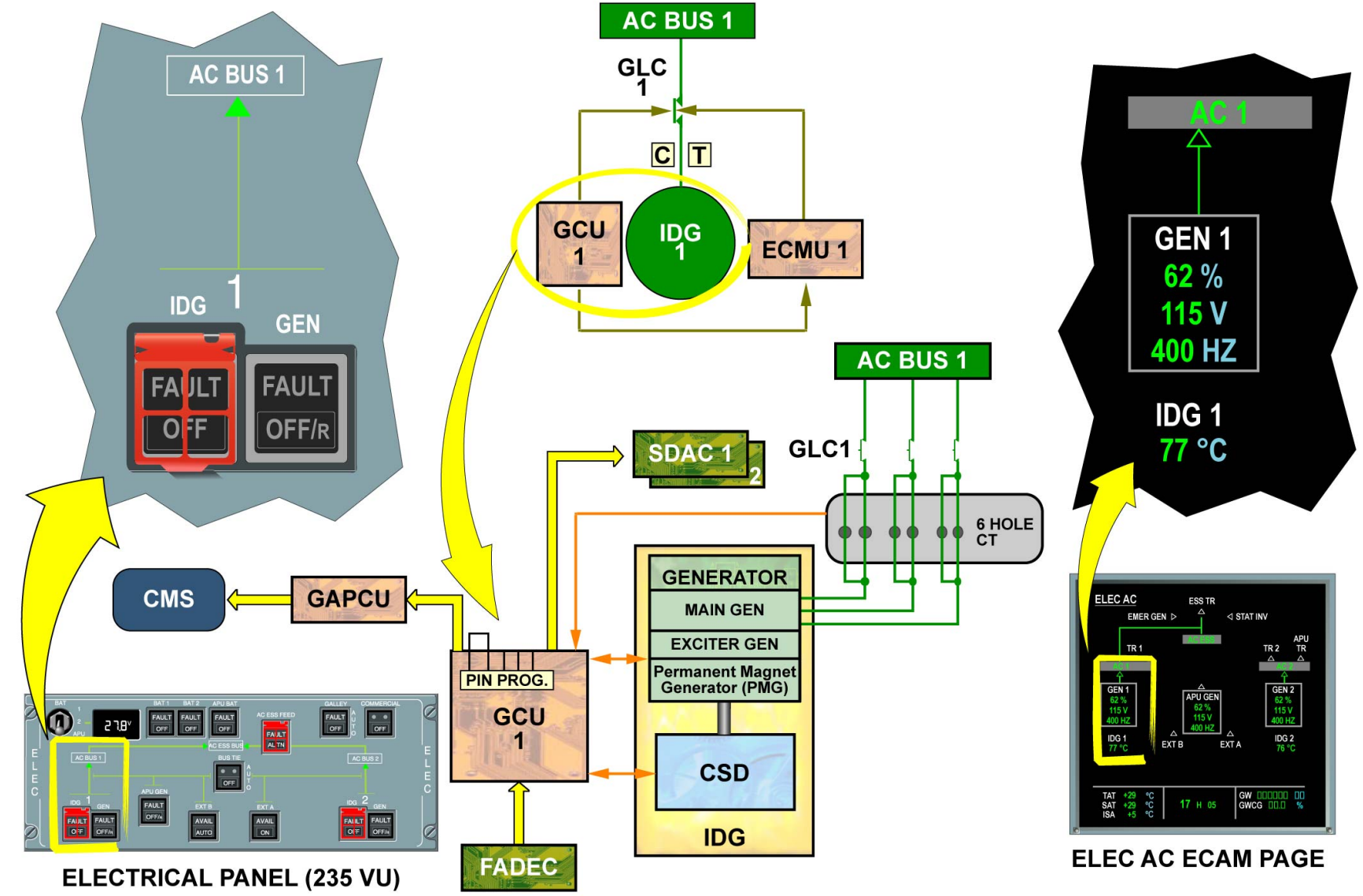

PRESENTATION - ELECTRICAL PANEL AND AC ECAM PAGE ... ECMU

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MAIN AC GENERATION D/O (3)

INTEGRATED DRIVE GENERATOR OPERATION

This topic shows the IDG operation.

IDG CONTROL P/B

The IDG can be manually disconnected, from the engine gear box, with the IDG P/B, installed on the overhead ELEC panel (235VU). When the engine is running, above the under-speed set point value (about 4900 RPM), action on this P/B immediately disconnects the IDG. During engine operation and upon IDG fault (overheat or abnormal oil low pressure), the IDG FAULT legend on panel 235VU comes on.

NOTE: The IDG FAULT legend comes on, related to an ECAM level 2 caution.

Action on the IDG P/B will lead the IDG to disconnect and the OFF legend to come on. With engine stopped, the IDG cannot be manually disconnected. An under-speed condition generated by the GCU inhibits the disconnection.

GEN CONTROL P/B

The GEN P/B on the overhead ELEC panel is used to connect or disconnect the generator and to reset the GCU. When the P/B is released out (off position), the OFF/R legend appears, the generator field is de-energized and the line contactor is open. When the P/B is pressed in (on position), the generator is connected as soon as the electrical parameters are within the limits.
The FAULT legend comes on (in ON position only) in the following cases:
- the related engine is shutdown,
- during operation with any incorrect parameter,
The GLC stays open due to a failure despite correct parameters
The FAULT information is sent to the ECAM. After fault detection, setting the GEN P/B to OFF and then to ON resets the GCU and the GEN.

GENERATOR SPEED CONTROL

The GEN speed is controlled by a system composed of a servo-valve in the IDG and an electronic control circuit in the GCU. The electronic control circuit controls the servo-valve, which in turn controls the CSD speed variation to keep the GEN at a constant frequency. The GCU does the speed control of the IDG whenever several conditions are met:
- the GCU is powered up,
- engine input speed to the IDG is between 4900 and 9120 RPM,
- no failure is shown in the servo valve control circuit.

IDG OIL SYSTEM

The IDG oil is used for cooling, lubrication and operation of the CSD and the cooling and lubrication of the GEN .

IDG OIL TEMPERATURE

There are two oil temperature sensors in the IDG:
- one sensor on the IDG oil inlet port,
- one sensor on the IDG oil outlet port.
These sensors allow the IDG oil temperature to be monitored.
The GCU transmits the oil outlet temperature to the SD EL/AC page for oil temperature indication.
When the Outlet Oil Temperature (OOT) reaches 152 °C (305.6 °F), an advisory mode is sent to the ECAM. If oil overheat detection is sensed (OOT > 185 °C (365 °F)), the warnings are given to the ECAM and FAULT legend appears on the IDG P/B, which requires a manual disconnection of the IDG (ECAM and BITE message: OIL OVHT).
A RISE indication is also displayed on the ELEC AC System Page. This is the difference between the oil in and oil out temperature.

G9409341 - GAUT0T0 - FM24D1000000003

IDG OIL PRESSURE

A Low Oil Pressure (LOP) switch installed on the IDG charge oil circuit monitors the oil pressure. The LOP switch sends a signal to the GCU when the IDG charge oil pressure is less than 140 PSI (9.65 bars). In LOP condition, that is not caused by under-speed, the IDG P/B FAULT legend comes on amber and an ECAM warning IDG 1(2) OIL LO PR is triggered.

The IDG scavenge oil filter has a Differential Pressure Indicator (DPI), which indicates a clogged filter condition. The switch is installed across the scavenge filter and related to a pop-out indicator installed on the IDG filter housing. In the case of a clogged filter, the DPI sends a signal to the GCU, which, in turn, sends a status message to the ECAM. A visual check of the pop-out is required. If the DPI is popped out, both filters (inlet and outlet) and oil must be removed, inspected and replaced according to Aircraft Maintenance Manual (AMM) procedures.

The DPI device is automatically inhibited during cold oil running conditions (under-speed), due to high oil viscosity.

IDG OIL LEVEL

The GCU includes a Remote Oil Level Sensor (ROLS) function that enables to know the IDG oil level status.

NOTE: In case of low oil level detection, the GCU generates a LOW OIL LEVEL message to the Central Maintenance Computer (CMC) via the GAPCU. A message is displayed on ground on the status page of the ECAM system display to inform the crew.

The ROLS sensor is installed in the IDG.

Eight minutes after engine shutdown, the GCU starts an oil level interrogation sequence. Then the sequence is supplied every six minutes. In the case of oil low-level detection, the GCU sends a status message to the ECAM. A visual check of the oil level sight glass is necessary. Oil servicing is done according to the oil level given by the oil level sight glass level indication colors (red, yellow, green).

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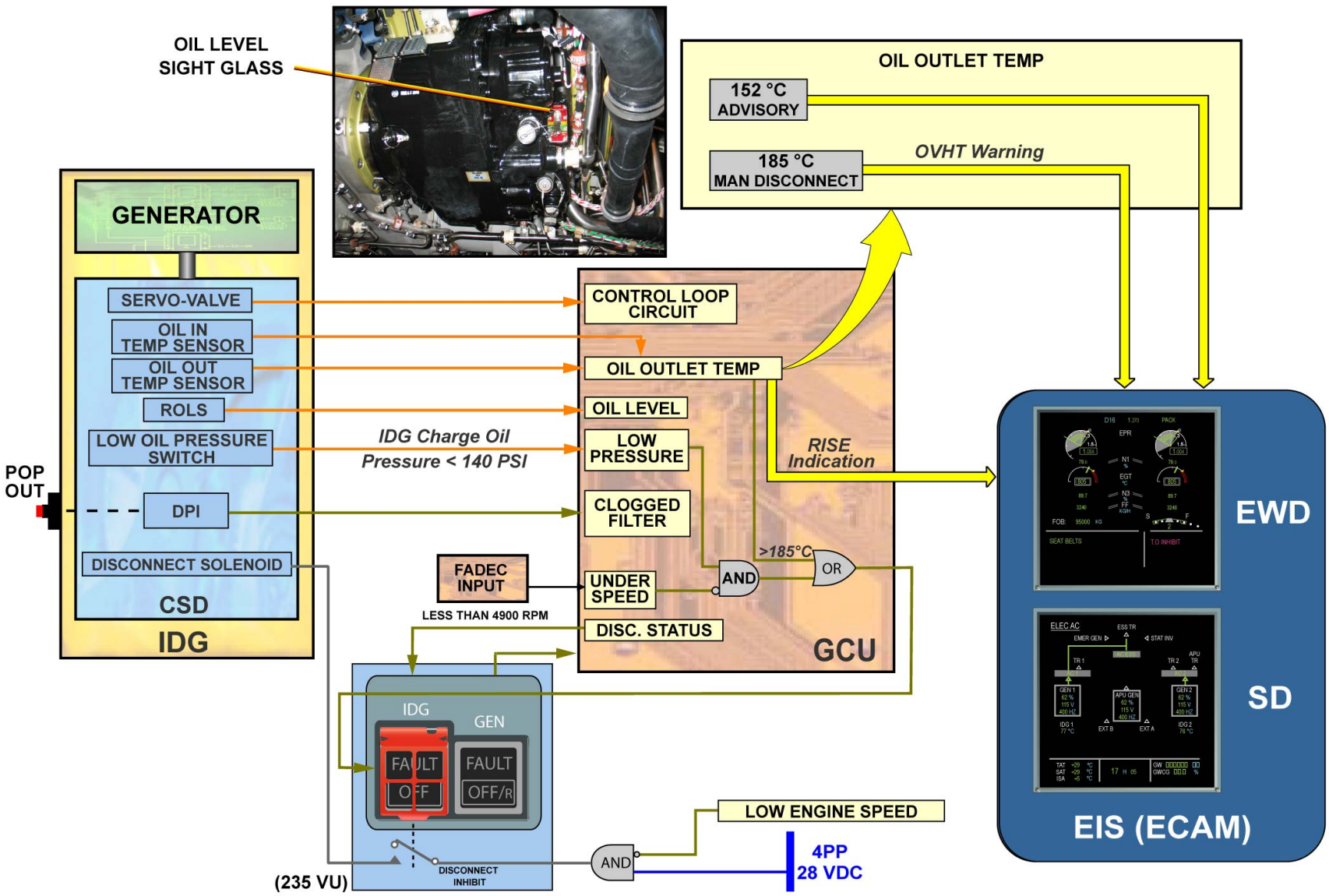

INTEGRATED DRIVE GENERATOR OPERATION - IDG CONTROL P/B ... IDG OIL LEVEL

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MAIN AC GENERATION D/O (3)

IDG OIL COOLING SYSTEM AND DISCONNECTION MECHANISM

This topic shows the IDG oil cooling system and the disconnection mechanism.

SPEED CONTROL LOOP

The speed control loop is composed of a servo-valve in the IDG and an electronic control circuit in the GCU that includes the Servo-Valve ReLaY (SV RLY). The electronic control circuit monitors the generator PMG frequency and compares it with a GCU internal frequency reference.
The difference between these two frequencies creates an error signal. This signal is used to control the servo-valve oil via the SV RLY to regulate the output speed.
The servo-valve maintains the desired generator frequency (400 Hz) by controlling the movement of a variable hydraulic unit according to the error signal. The variable hydraulic unit acts on a rotary part allowing the output speed of the CSD to be adjusted. Notice that during NBPT condition, the PMG frequency is compared with the frequency reference of the source connected in parallel.

IDG DISCONNECTION MECHANISM

When the engine is running (input speed above 4875 RPM), the FAULT legend of the IDG P/B comes on if:
-the IDG oil pressure is less than 140 PSI (9.65 bars), or
-the IDG oil outlet temperature is above 185 °C (365 °F).
In both cases, the IDG must immediately be disconnected via the IDG P/B. When the IDG P/B is pressed, the solenoid control relay is energized and connects the 28V DC to the disconnection solenoid that will open the disconnect clutch. The FAULT legend goes off if for an OIL OVHT the oil temp goes below 185 °C (365 °F). Then the IDG P/B OFF legend comes on.
The OFF legend remains on until the clutch is reset and the engine is running. The IDG reset can only be done on ground with engine shutdown, by pulling the reset ring mounted on the IDG casing. In under-speed condition (input speed below 4875 RPM) it is not possible to disconnect the IDG. Note that a detected under-speed also inhibits some protection circuits (under-frequency and under-voltage).
Example of the A340 IDG Disconnection / Reconnection film.

NOTE: Some procedures for this operation are not shown on the film (e.g. opening of some circuit breakers). Always follow the maintenance manual for this operation.

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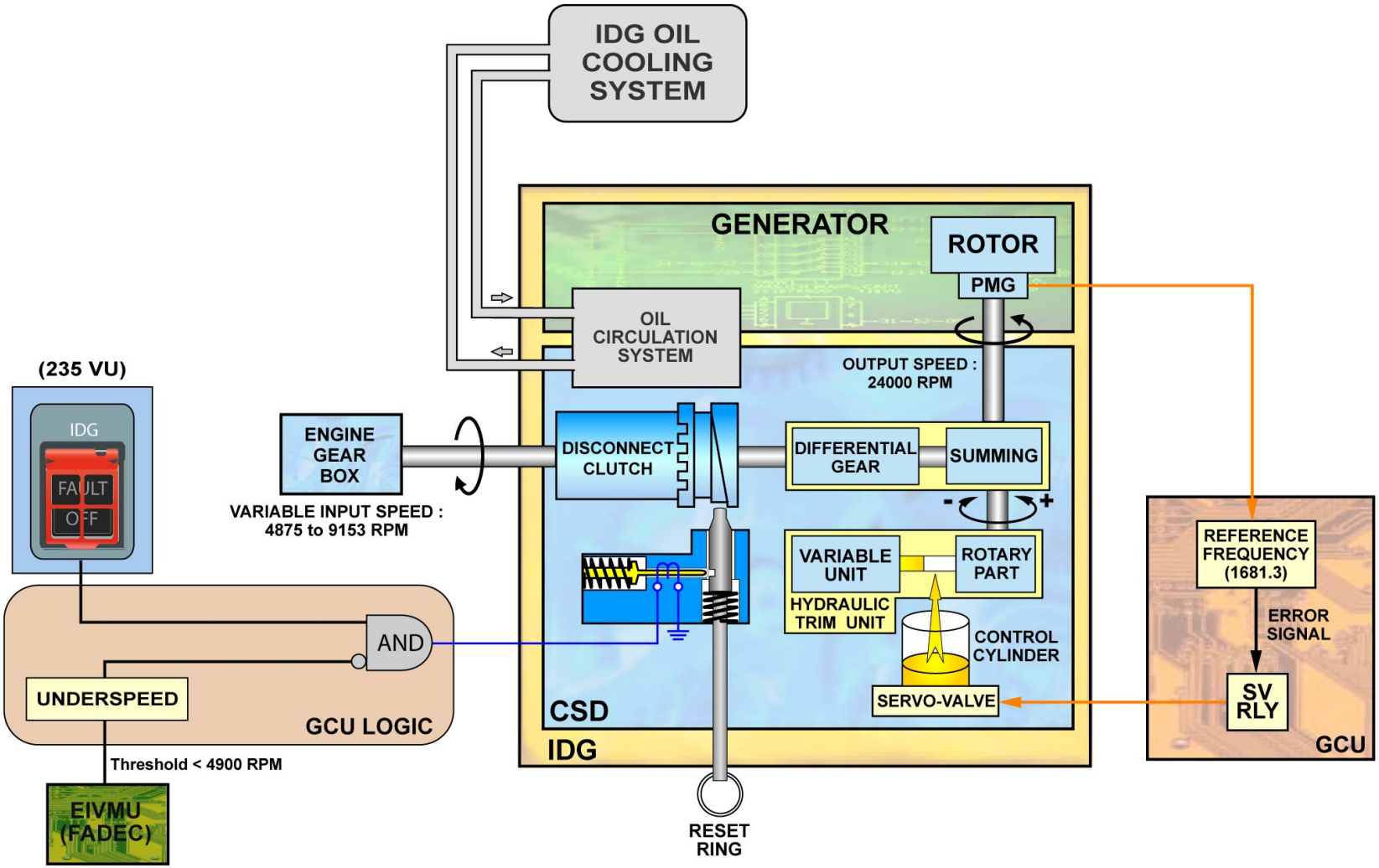

IDG OIL COOLING SYSTEM AND DISCONNECTION MECHANISM - SPEED CONTROL LOOP & IDG DISCONNECTION MECHANISM

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IDG OIL COOLING SYSTEM AND DISCONNECTION MECHANISM - SPEED CONTROL LOOP & IDG DISCONNECTION MECHANISM

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MAIN AC GENERATION D/O (3)

IDG OIL COOLING SYSTEM AND DISCONNECTION MECHANISM (continued)

OIL COOLING

Two types of oil cooling system exist:
- oil cooling via Air Cooled / Oil Cooler system,
- oil cooling via Engine Fuel / Oil Cooler system and Air / Oil Heat Exchanger.

The Air Cooled / Oil Cooler system is available for the A330 with Rolls Royce (RR) engines. The Air Cooled / Oil Cooler is composed of a heat exchanger matrix and a duct.
The heat exchanger is connected to the IDG oil system by two oil connections (in and out). The oil flows through the matrix and distributes the heat to the matrix fins.
If the oil is cold and does not flow easily through the matrix, a pressure relief valve will open. This will let the oil flow directly from the inlet connection to the outlet connection and back to the source. When the oil temperature increases, the pressure relief valve closes and the oil flows again through the matrix.
An A330 with a Pratt & Whitney (PW) or General Electrics (GE) engine uses an Air / Oil Heat Exchanger and an Engine Fuel / Oil Cooler for the IDG oil cooling.
The IDG oil outlet is cooled via the Air / Oil Heat Exchanger by:
-a fan air during high ENG power time (take-off, climb, cruise), or
-2.5 bleed cooling air during low ENG power time (ground idle, taxi, idle descent).
The Air valve, regulated by the Electronic Engine Control, keeps an IDG oil temperature less than 105 °C (221 °F).
Then IDG oil flows in the Engine Fuel / Oil Cooler to keep an IDG oil inlet temperature between 70 °C (158 °F) and 105 °C (221 °F).

NOTE: Note: the Air / Oil Heat Exchanger valve is spring loaded in case of no information from the Electronic Engine Control to let the oil cool down..

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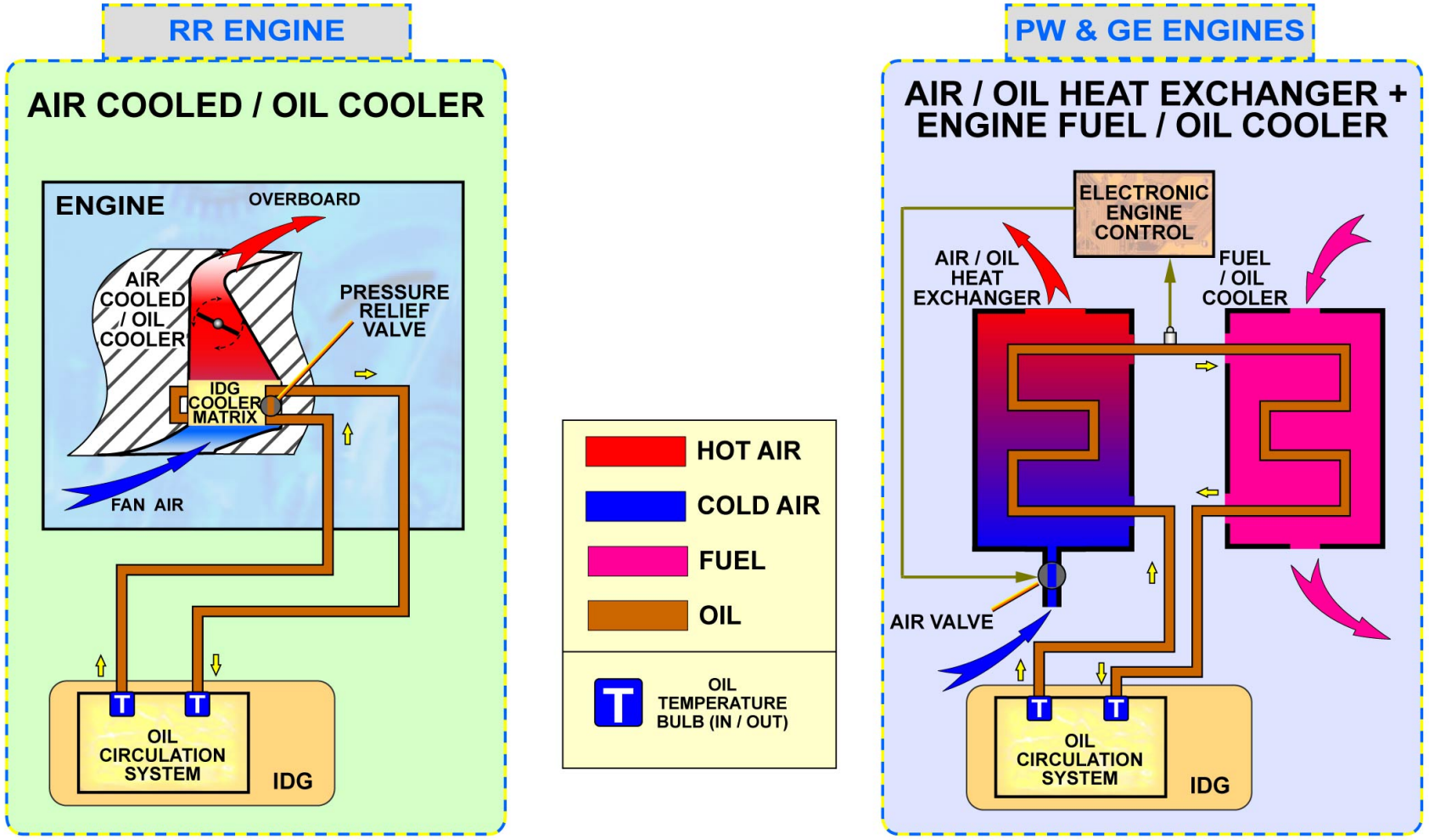

IDG OIL COOLING SYSTEM AND DISCONNECTION MECHANISM - OIL COOLING

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MAIN AC GENERATION D/O (3)

MAIN AC ELECTRICAL SYSTEM OPERATION

This topic shows the main AC electrical system operation.

CONTROL AND PROTECTION

The GCU controls the connection and disconnection of the IDG to and from the AC ELEC system. These controls are mainly done by means of 3 internal relays:
- the Generator Control Relay (GCR) controls the generator excitation,
- the Power Ready Relay (PRR) controls the GLC and the NBPT,
- the SV RLY controls the generator rotor speed by means of the servo-valve.

If a protection function is triggered, the GCR, the PRR and, in some cases, the SV RLY are de-energized.

VOLTAGE REGULATION

The GCU monitors the Point Of Regulation (POR) in order to keep the voltage at nominal value (115V AC) at this point. The POR is installed at the end of the generator feeder, upstream of the GLC. The voltage regulation is gotten through the regulation of the current in the exciter field.
The output from the PMG is connected via the GCR to the excitation and regulation control module, where it is converted into DC voltage and applied to the exciter field. The voltage frequency regulation module senses the average of the three phases at the POR and compares it against a reference voltage. If a difference exists, the voltage regulator adjusts the exciter field current as needed to keep a constant voltage at the POR.

UNDER-SPEED

Pin programming activates the underspeed set point. The Engine Interface and Vibration Monitoring Unit (EIVMU) gives ENG speed information to the GCU for under-speed set point. The EIVMU is a part of the FADEC. When the ENG speed falls below the under-speed threshold (4900 RPM), the PRR trips and the excitation is biased off due to under-frequency at PMG output (<335 Hz). If under-speed is detected, no reset action via the GEN P/B is necessary. If ENG speed data is not available, the GCU refers to the PMG frequency (1681.3 Hz).
If ENG speed data is below the set point, the IDG disconnection is inhibited.

OVER-VOLTAGE

Typically, the GCU has an over-voltage protection function if the highest individual phase at POR reaches 130 +/- 1.5V AC. Then, the PRR and the GCR are tripped to protect the whole network. Notice that the higher the over-voltage, the faster the relays are tripped (inverted time delay).

OVER-FREQUENCY

The GCU starts the over-frequency protection if the PMG frequency is above 435 Hz, for at least 4 seconds, the GCU trips the PRR, GCR and SV RLY.

DIFFERENTIAL PROTECTION

The differential protection is based on the comparison of each phase of the line 6 hole CTs and the GEN CTs in the IDG. If the difference of current is above 50 +/- 10 A for at least 60 milliseconds, the PRR and GCR are tripped. The differential protection circuit reset is done via the GEN P/B and this protection can be reset twice. After 2 reset attempts, the GCU must be powered down (cold start) to reset the protection latch-in software.

OVERLOAD AND OVERCURRENT

The IDG (GEN) CTs supply current sensing information to the GCU. In case of overload or over-current, the related GCU protection circuits are triggered. If the overload is still there for 10 seconds after the start,

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the GCU only sends a signal to the ECMUs to isolate the related galley from the network. No tripping occurs.
The automatic shedding is done by the ECMUs, and no ECAM warning is triggered. If the automatic shedding is not done, the ECAM is triggered and the FAULT legend on the GALLEY P/B comes on. The crew has to press the GALLEY P/B to manually shed the galley load to reduce the generator load.
If an over-current is detected, after the inverted protection time delay, the Bus Tie Contactor (BTC) is locked in the OPEN position. If the fault continues, the GEN is de-energized (via the GCR) and the GLC is opened (via the PRR).

INADVERTENT PARALLEL TRIP

The power supply logic to each AC main bus bar is established through the ECMU control system. Furthermore, the NBPT allows two AC sources to be connected momentarily during the transfer phase. After transfer completion, a special protection in the ECMU and GCU (lock out circuit) avoids an Inadvertent Paralleling Trip (IPT) condition.

FIRE PROTECTION

In case of ENG fire, if the related fire switch is released out, a 28V DC signal is sent to the related GCU that shuts down its IDG. This signal is not latched, thus no reset is necessary.

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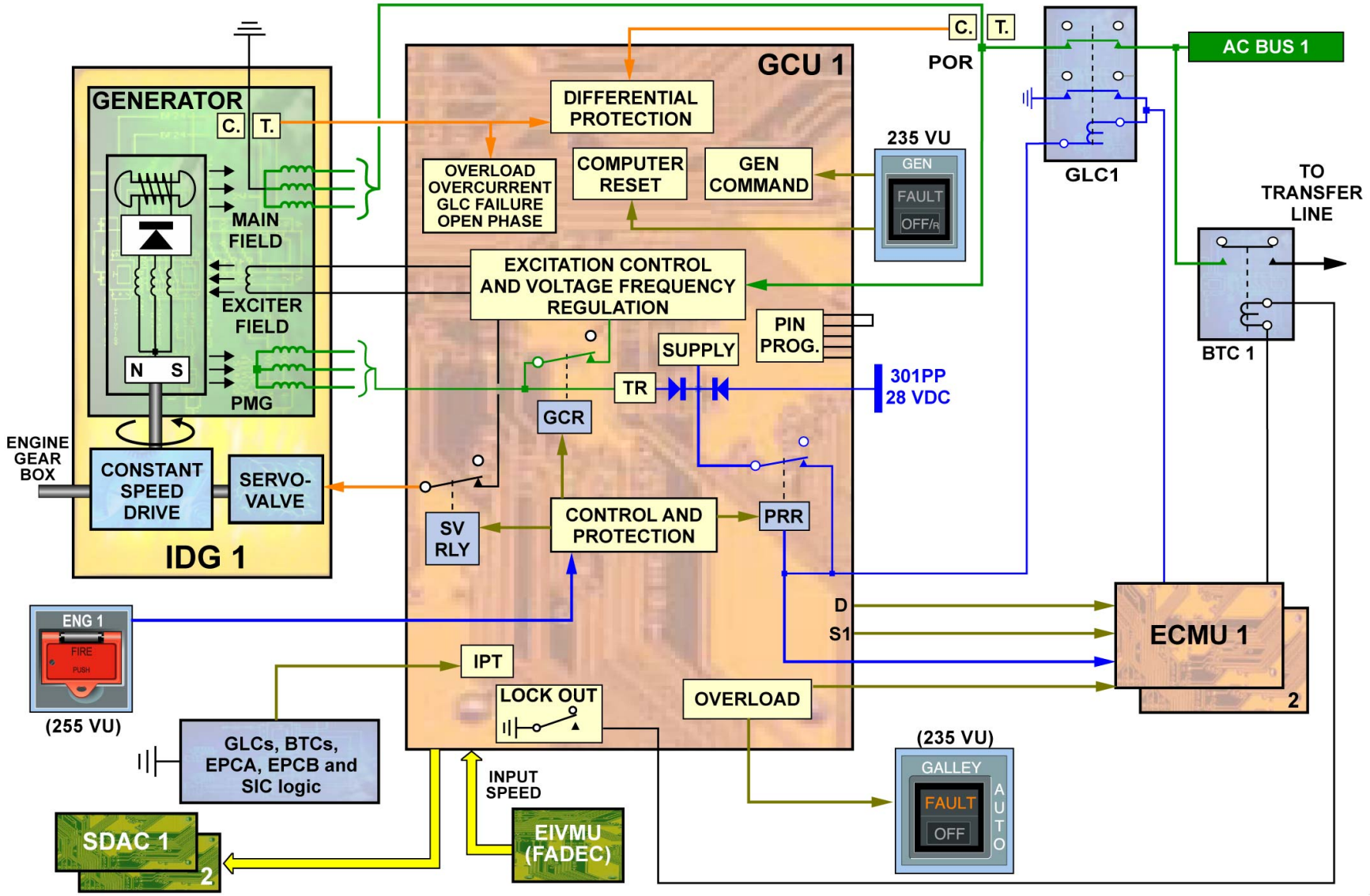

MAIN AC ELECTRICAL SYSTEM OPERATION - CONTROL AND PROTECTION ... FIRE PROTECTION

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AUXILIARY AC GENERATION D/O (3)

DESCRIPTION

Three sources can provide AC auxiliary generation:
- the APU generator,
- the two external power receptacles (EXT PWR A and B).

These three sources are controlled and monitored by the Ground and Auxiliary Power Control Unit (GAPCU) and the Electrical Contactor Management Units (ECMUs) via associated contactors (External Power Contactors (EPCs) and APU Generator Line Contactor (AGLC)).

GAPCU

The GAPCU ensures all functions of the conventional APU Generator Control Unit (APU GCU) and Ground Power Control Unit (GPCU) such as the control and the monitoring of auxiliary sources.
The GAPCU controls, monitors and regulates the APU generator (eg: voltage regulation). It also controls and monitors the two EXT PWR parameters (voltage, frequency).
The GAPCU and ECMUs control the connection to the network of the sources via the AGLC and EPCs.
The main task of the ECMUs is to control and monitor the AGLC and EPCs in No Break Power Transfer (NBPT) conditions with the A/C on ground.

APU GENERATOR

The APU generator can supply all or part of the normal network, depending on the priority logic of the network supply.
The APU generator is a two pole high speed (24000 RPM) brushless spray oil cooled generator. Speed regulation is made by the APU (there is no Constant Speed Drive (CSD)); therefore, it operates in the same manner but it is not interchangeable with the Integrated Drive Generators (IDGs).

The APU oil system is also used to cool and lubricate the APU generator. Therefore, the oil system is entirely monitored by the APU Electronic Control Box (ECB).

EXTERNAL POWER

Two EXT PWR receptacles (A and B) are located aft of the nose landing gear well.
The external power receptacles can supply the entire aircraft network by means of one or two Ground Power Units (GPUs).
The EPCs enable the GPU to be connected to the transfer circuit.
These contactors are controlled and monitored by the GAPCU and the ECMUs.

FEEDER LINE

The APU feeder line is split into 2 cables per phase (parallel feeders). They are routed through the cargo ceiling to rack 700VU in the avionics compartment, where they are sent though a six-hole Current Transformer (CT) before connection to the AGLC.
The feeder line and the APU generator are protected by the differential open cable protection.
The EXT PWR feeder lines are not split into 2 cables (single feeders). They are routed directly to the avionics compartment rack 700VU.
There are 3 CTs upstream the EPCs (one per phase), per EXT PWR source (A and B) to monitor the quality of the power supply.

APU GEN AND EXTERNAL POWER CONTROL P/BSW's

The APU GENerator P/BSW and the two EXT PWR (A and B) P/BSWs are located on the overhead ELECtrical panel and have 2 stable operating positions.
When selected ON (EXT PWR A, Not "OFF" for APU GEN and AUTO for EXT PWR B), they enable the GAPCU to control, monitor and connect the APU GEN and the external power sources to the aircraft network.

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A manual deselection of the APU GEN switch de-energizes and disconnects the APU GEN and resets the APU GEN control part in the GAPCU.
A manual deselection of the EXT PWR switch disconnects the GPU from the A/C network.

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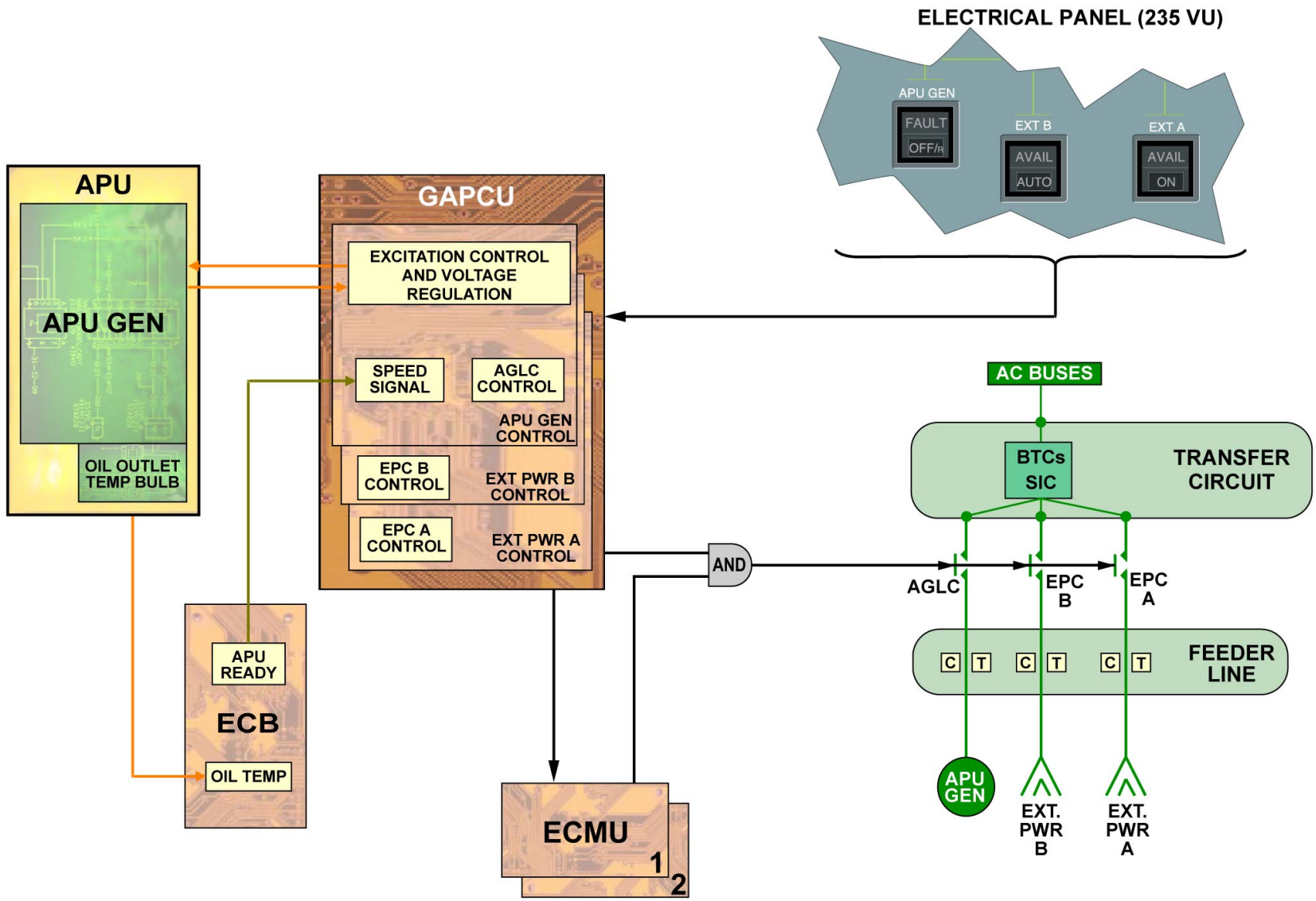

DESCRIPTION - GAPCU ... APU GEN AND EXTERNAL POWER CONTROL P/BSW'S

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AUXILIARY AC GENERATION D/O (3)

GAPCU DESCRIPTION

The GAPCU controls both the APU generator channel and external power A and B sources through contactors and relays.
These contactors and relays (AGLC, EPCs, System Isolation Contactor (SIC), Power Ready Relay (PRR), External Power Ready Relay (EPRR)) can only be closed when the correct conditions exist. They are opened manually or automatically (control and protection).
In addition, the GAPCU performs:
- a back-up control for external power A only,
- BITE analysis,
- communication functions between Generator Control Units (GCUs), ECMUs, ECB, Centralized Maintenance Computer (CMC), Landing Gear Control and Interface Unit 1 (LGCIU 1),
- interface with ECAM (via the System Data Acquisition Concentrators (SDACs)), APU, AGLC.

POWER SUPPLY

In normal operation, the GAPCU internal power supply module can be supplied by:
- the APU Permanent Magnetic Generator (PMG) via the APU (Transformer Rectifier) TR,
- the EXT PWR A via an internal TR.

If a total power supply failure occurs (loss of APU GEN and EXT PWR A and B), the Battery Bus bar 301 PP (DC BAT BUS) supplies the GAPCU via circuit breaker 39XG. This safety is the GAPCU back-up supply.

COMMON FUNCTION

The GAPCU communicates with the GCUs, and the CMC.
The GAPCU communicates with each of the GCUs via MIL 1553 links.

The GAPCU always initiates the transfer of information from the GCUs, and communicates during the 2 transmission modes (normal and interactive).
In normal mode (FLIGHT), the GAPCU periodically interrogates each GCU for channel and fault status.
The GAPCU also receives the GCU Line Replaceable Unit (LRU) identification and pin programming information (A/C and engine types).
In interactive mode (only on ground when requested from CMC), the normal mode may be interrupted. The GAPCU will request a self-test of each of the GCUs and will perform its own self-test.
The GAPCU is a type 1 computer. It communicates with the CMC via two ARINC 429 links.
During the normal mode of transmission, the GAPCU will continually send its own fault data and that of the GCUs to the CMC.
Access to the interactive menu is gained through the Electrical Power Generation System (EPGS) system page, displayed on the MCDU System/Report Test page.
Upon request from the CMC, the GAPCU stops the normal mode of transmission and enters the interactive mode to follow CMC commands.
Then, the GAPCU transmits the EPGS main menu.
The GAPCU interfaces with two SDACs via an ARINC 429 link.
During all operation modes, the GAPCU will continually transmit data to the SDACs. The SDACs will use this data to provide information and warnings to the ECAM.
The GAPCU receives an air/ground mode signal from LGCIU1.
This LGCIU 1 signal is used for the ground/flight status.
Due to NBPT reasons, when the aircraft is on ground, the APU GEN has priority over the EXT PWR B. Once the APU generator is connected, phase A is sent to the Frequency Reference Unit (FRU).
The FRU signal is sent to other GCUs and serves as a reference for further NBPTs.

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If the APU GEN is in overload condition, the GAPCU informs the ECMU which sheds the GALLEY and indicates the information in the cockpit.

APU GEN CONTROL BOARD

FUNCTIONS:

The GAPCU also controls, monitors and protects the APU generator supply to the network.
It ensures the following main functions:
- control of the field excitation through the Generator Control Relay (GCR),
- voltage regulation,
- control of the AGLC through the PRR in conjunction with the ECMU1,
- control and protection of the APU generator and the network.

APU ECB ensures the speed regulation. At 95 % RPM, the ECB provides an APU ready signal to the control part of the GAPCU.
AGLC CONTROL AND MONITORING:
The AGLC connects the APU GEN to the Transfer Circuit. It is controlled and monitored by the GAPCU and the ECMU 1. The position of the AGLC is monitored by the FAULT legend on the APU GEN P/BSW.

EXT PWR CONTROL BOARD

FUNCTIONS:

The GAPCU controls and monitors EXT PWR contactors and relays.
When EXT PWR A and/or B are connected, the GAPCU performs the following functions:
- monitoring,
- interlock function,
- EPC control,
- protection function,
- FRU function for NBPT,
- BITE function,
- communication and interface.

The diagram shows the connection for External Power A.

MONITORING:

The GAPCU permanently monitors the quality of the delivered ground power.
At least one faulty parameter automatically disconnects the ground power from the transfer line (EPRR and EPC open).
The interlock system is also activated (Interlock Monitoring Relay (IMR) open) and the GPU is electrically disconnected from the aircraft.
The IMR enables a holding supply to be connected to the GPU line contactor.
It is not possible to connect a faulty power source to the network.

INTERLOCK:

The conditions for the IMR to be closed are:
- the 28 VDC control voltage from the GPU is within accepted limits (<42 VDC and <13 VAC),
- the delivered power quality, sensed at a Point Of Regulation (POR), is accepted by the Control and Protection Module.

The closed IMR connects 28 VDC via pin F to the GPU.
This interlock voltage acts as a holding supply for the GPU output contactor.
If the control voltage is not within the limits, the IMR opens to electrically disconnect the GPU and sends a signal to the valid external power interlock module to open the EPRR (EPC will open).
The closed IMR status is also sent to the valid EXT PWR (Valid EP) interlock circuit which will close the EPRR, provided the quality of the power voltage is accepted by the control and protection module.
For EXT PWR A, the green legend AVAIL illuminates.
For EXT PWR B, the green legend AVAIL illuminates.

EXTERNAL POWER CONTACTOR CONTROL:

The closed EPRR provides 28 VDC to the solenoid of the EPC.
As soon as the EXT PWR P/BSW is pressed, the ECMUs are notified that an external power is ready to be involved in an NBPT.

For EXT PWR A, the blue legend ON illuminates.
For EXT PWR B, the blue legend AUTO illuminates.

PROTECTION:

The GAPCU has to be powered to allow APU or EXT PWR sources to be connected to the aircraft electrical network.
In case of a total GAPCU power supply failure, the BATTERY BUS will ensure the necessary supply to the GAPCU.
The GAPCU has a BACK UP module which contains software, in the case the GAPCU main operating software fails. The BACK UP module operates on the EXT PWR A side (board) in order to recover the availability of EXT PWR A. The BACK UP module is, in this case, supplied by the HOT BUS.

OVERVOLTAGE:

Overvoltage (OV) protection is accomplished by monitoring the highest phase at POR.
An OV condition exists when the highest phase voltage exceeds 130+/-1,5 VAC for at least 50 ms.
After an inverse time delay, the IMR and EPRR are tripped.

UNDERVOLTAGE:

Undervoltage (UV) is sensed in the same way as overvoltage.
An undervoltage condition exists when the lowest phase voltage is less than 101,5+/-1,5 VAC.
After a 4,5 second time delay max, the EPRR and the IMR are tripped.

OVERLOAD:

The internal CT senses the overload.
An Overload condition exists when the current is greater than 260+ -15 A on any phase for 10 seconds max.
The galley-shed relay sends a signal to the ECMUs and to the galley P/BSW.
The ECMUs reply by shedding galley loads, depending on the supply configuration faults.
If the overload condition persists for an additional 2 seconds, after the load shedding action by the ECMUs (galley switch FAULT legend on), the ECAM warnings are triggered and the message EXT PWR A (or B) OVERLOAD appears.
All galley loads must be shed by setting the galley P/B to OFF. The message GALLEY OFF appears.
If after galley shedding an overload is still detected, the overcurrent protection will be triggered after an inverse time delay: the IMR and EPRR are tripped.

OVERCURRENT:

The internal CT senses the overcurrent (OC).
An overcurrent condition exists when the current on any one phase exceeds 277 A.
Once an overcurrent situation is sensed, the GAPCU relays the information to the ECMU as network status information.

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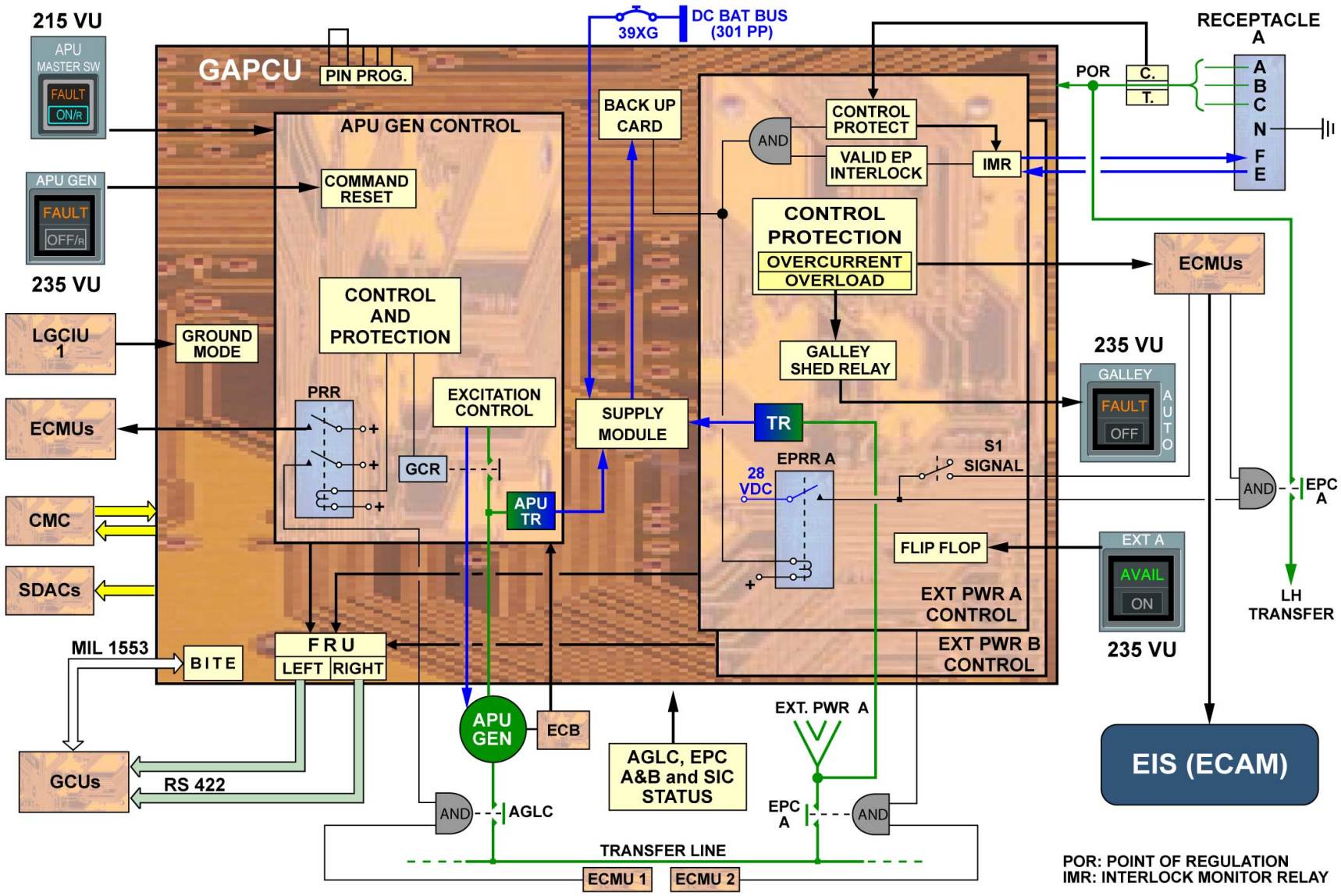

GAPCU DESCRIPTION - POWER SUPPLY ... EXT PWR CONTROL BOARD

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AUXILIARY AC GENERATION D/O (3)

APU GENERATOR

The APU generator is connected to the APU gearbox, which turns at 24000 RPM. The APU ECB will keep the speed constant through the control of the APU shaft speed via the APU gearbox (APU ECB controlling the APU fuel control unit).
The APU generator is cooled and lubricated by oil, which is supplied from the APU.
The oil flows through two ports (in and out), in its mounting flange.
The oil temperature is monitored by the temperature bulb, which is connected to the ECB. If oil temperature reaches 185 °C (365 °F), the ECB orders an APU shutdown.

APU GENERATOR CONTROL P/BSW

The APU GEN P/BSW has two stable positions.
In OFF position (released out):
- the white legend (OFF/R) comes on,
- the generator is de-energized and disconnected,
- the GAPCU is reset.

In ON position (pressed in):
- the OFF legend goes off,
- the generator is excited and connected if all parameters are correct.

The FAULT legend comes on amber if:
- the APU is running at a speed greater than 95% and one of the parameters is not correct,
- or AGLC stays open due to a failure.

To reset the GAPCU after a failure, the APU generator P/BSW must be set to OFF and then ON again.

NORMAL OPERATION

When the APU GEN P/BSW is set to ON and the APU starts running, an APU initialization signal (D signal) is sent to ECMU 1 and the PMG is active.

If the PMG frequency is greater than 335 Hz (above 95 %) and no protection functions is triggered (no anomaly), the GCR closes and the generator is excited.
ECMU1 generates a ground signal, depending on the priority logic and AIR/GROUND configuration.
On ground, the APU GEN control card sends the S1 signal required for a NBPT to the ECMUs. ECMU1 will synchronize the APU GEN output with the power source actually supplying the aircraft network.
The APU ready signal is sent from the ECB if all APU GEN parameters are correct. The PRR closes and connects 28 VDC to the AGLC and provides a ground signal to ECMU 1.
The AGLC closes and connects the APU generator to the transfer circuit according to the supply priority logic.
The AGLC is controlled and monitored by the GAPCU and ECMU1.
The GAPCU monitors the AGLC and ECMU 1 controls its operational state (open or close).

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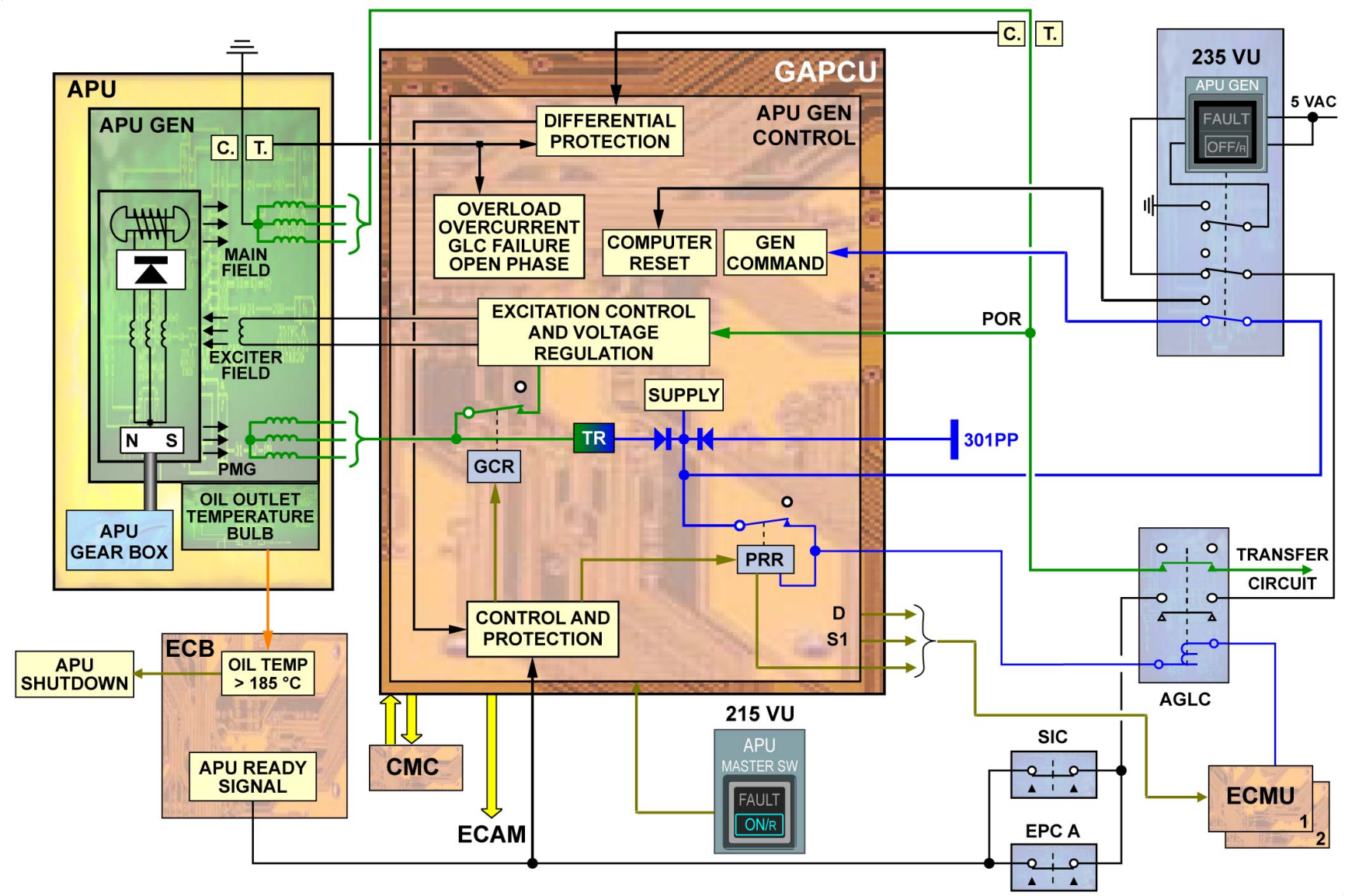

APU GENERATOR - APU GENERATOR CONTROL P/BSW & NORMAL OPERATION

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AUXILIARY AC GENERATION D/O (3)

APU GENERATOR (continued)

ABNORMAL OPERATION

The internal CT of the APU GEN monitors the main feed output current (all phases). This CT permanently transmits its output value to the differential protection module of the GAPCU.
A similar monitoring is done on the feeder line upstream of the AGLC.
In the case of abnormal current detection, the differential protection module activates the control and protection module.
The GCR and PRR open. The generator is disconnected and de-energized and the AGLC is open.
A failure message is sent to the CMC, and to the ECAM via the SDACs for ECAM operational information.
The FAULT legend on the APU GEN P/BSW comes on amber. Note that the FAULT legend also comes on if the AGLC stays open due to a system failure.
To reset the GAPCU after a failure, the APU GEN P/BSW must be set to OFF and then pressed IN again.

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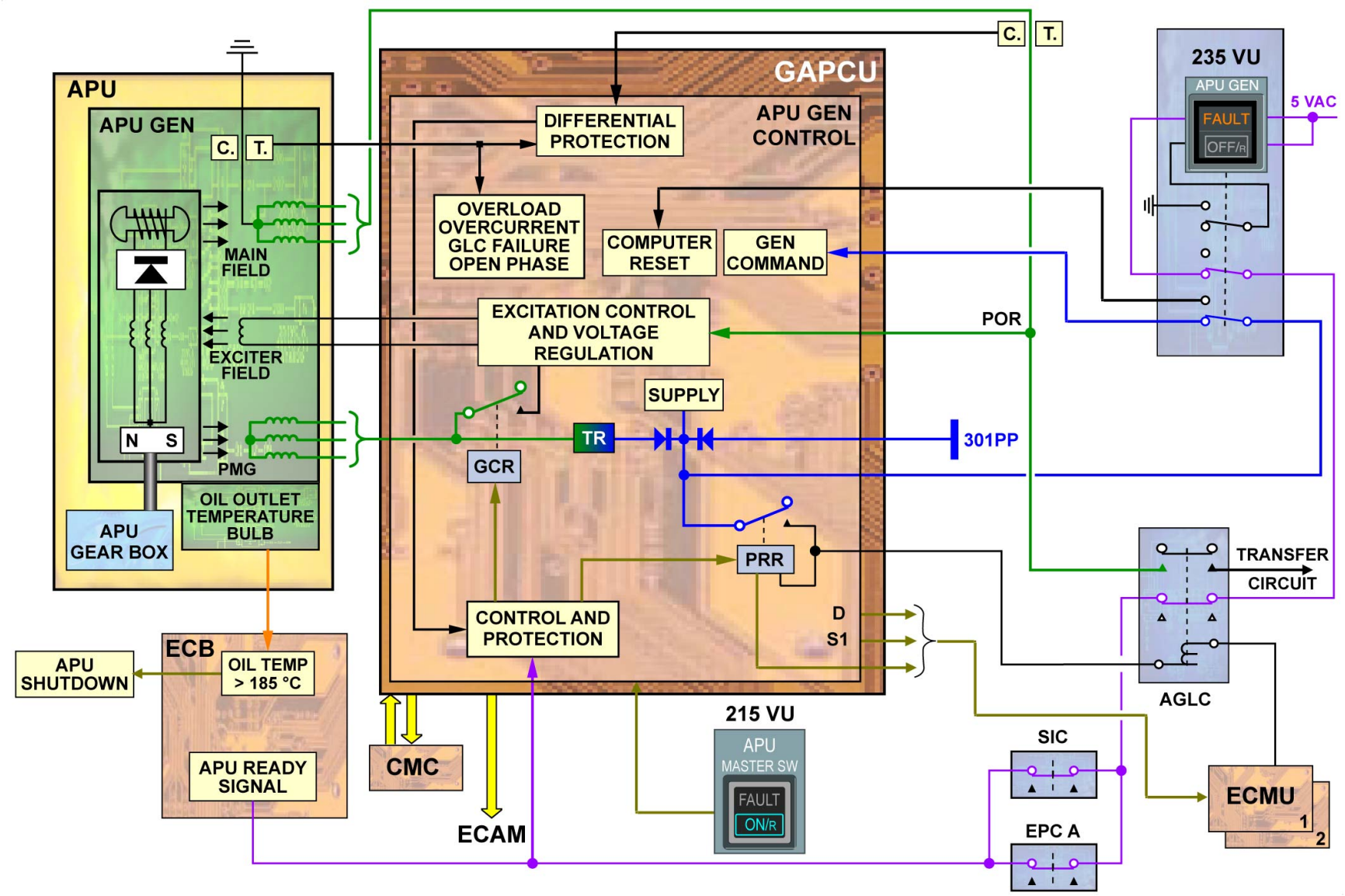

APU GENERATOR - ABNORMAL OPERATION

AUXILIARY AC GENERATION D/O (3)

EXTERNAL POWER

NORMAL OPERATION - EXT PWR CONNECTED AVAIL

The GAPCU controls the electrical connection or disconnection of the external A and B GPU.
This control is provided by two internal relays:
- the IMR,
- the EPRR.

The IMR, when energized, connects a holding supply to the GPU:
when the external DC input voltage is lower than 42 VDC,
or the external power A (B) channel fault signal is absent.
The EPRR is energized when the GPU is properly connected and all parameters are correct (no protection functions triggered).
As soon as the ground power unit A (B) is connected, the GAPCU analyzes the voltage delivered to the external power receptacle. If all parameters are correct, the GAPCU triggers the following:
- illumination of the green AVAIL legend of the EXT A (B) P/BSW, located in the overhead ELEC panel,
- illumination of the amber EXT PWR A (B) AVAIL indicator and the white EXT PWR A (B) NOT IN USE indicator, located on the EXT PWR panel 925VU, as long as no EXT PWR is connected to the aircraft network (EXT PWR available but not in use).

A light test function on the EXT PWR panel 925VU is used to test the EXT PWR A (B) AVAIL and the EXT PWR A (B) NOT IN USE indicator.
The closed EPRR connects power from the TR via the Positive Temperature Circuit (PTC) to the busbar 104XG in order to supply the following items:
- to the solenoid of EPC A,
- to the EXT PWR A NOT IN USE light via contactor 6XX (maintenance bus switch off),
- to the EXT PWR A AVAIL light,
- to the solenoids of relays 25XG and 9XG EXT PWR A P/BSW light and status message to ECMUs.

When no anomaly is detected, relay 25XG closes and controls the 5 VAC supply for the AVAIL legend from the internal power supply module.

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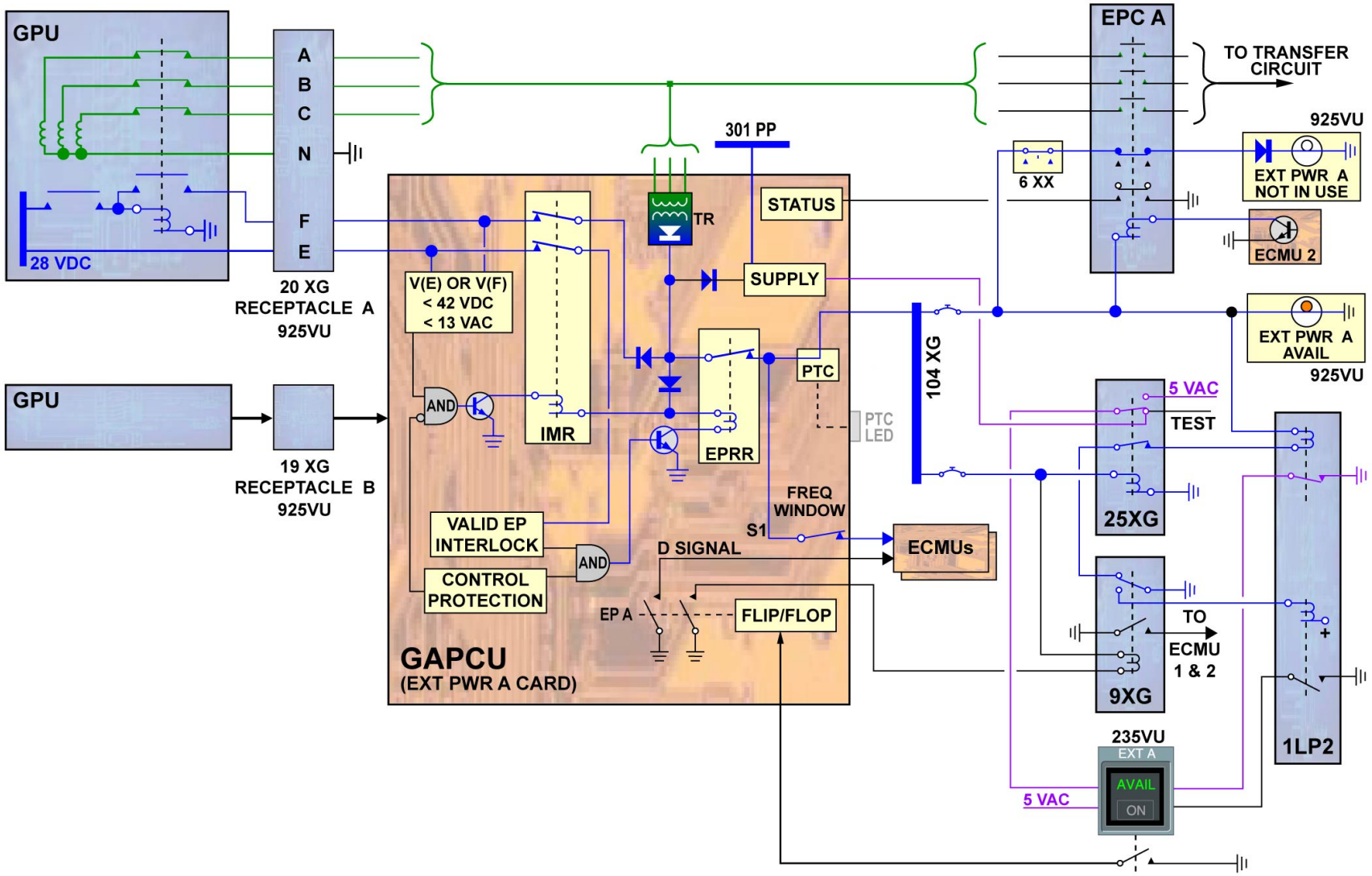

EXTERNAL POWER - NORMAL OPERATION - EXT PWR CONNECTED AVAIL

G9409341 - GAUT0T0 - FM24D2000000002

AUXILIARY AC GENERATION D/O (3)

EXTERNAL POWER (continued)

NORMAL OPERATION - EXT PWR ON

When the EXT PWR P/BSW is pressed, the flip-flop provides the D signal to both ECMUs for NBPT function, and a ground signal to the solenoid of relay 9XG. The closed relay 9XG cuts the supply for the AVAIL legend and illuminates the ON (AUTO for EXT PWR B) legend via 1LP2.
Then ECMU2 provides a ground signal to close the EPC A, provided the S1 signal for NBPT function is valid.
The GPU output is now connected to the transfer circuit.
The EXT PWR NOT IN USE light, on 925VU, goes off.
The connection of the ground power to the bus bars depends on the supply and transfer logic.

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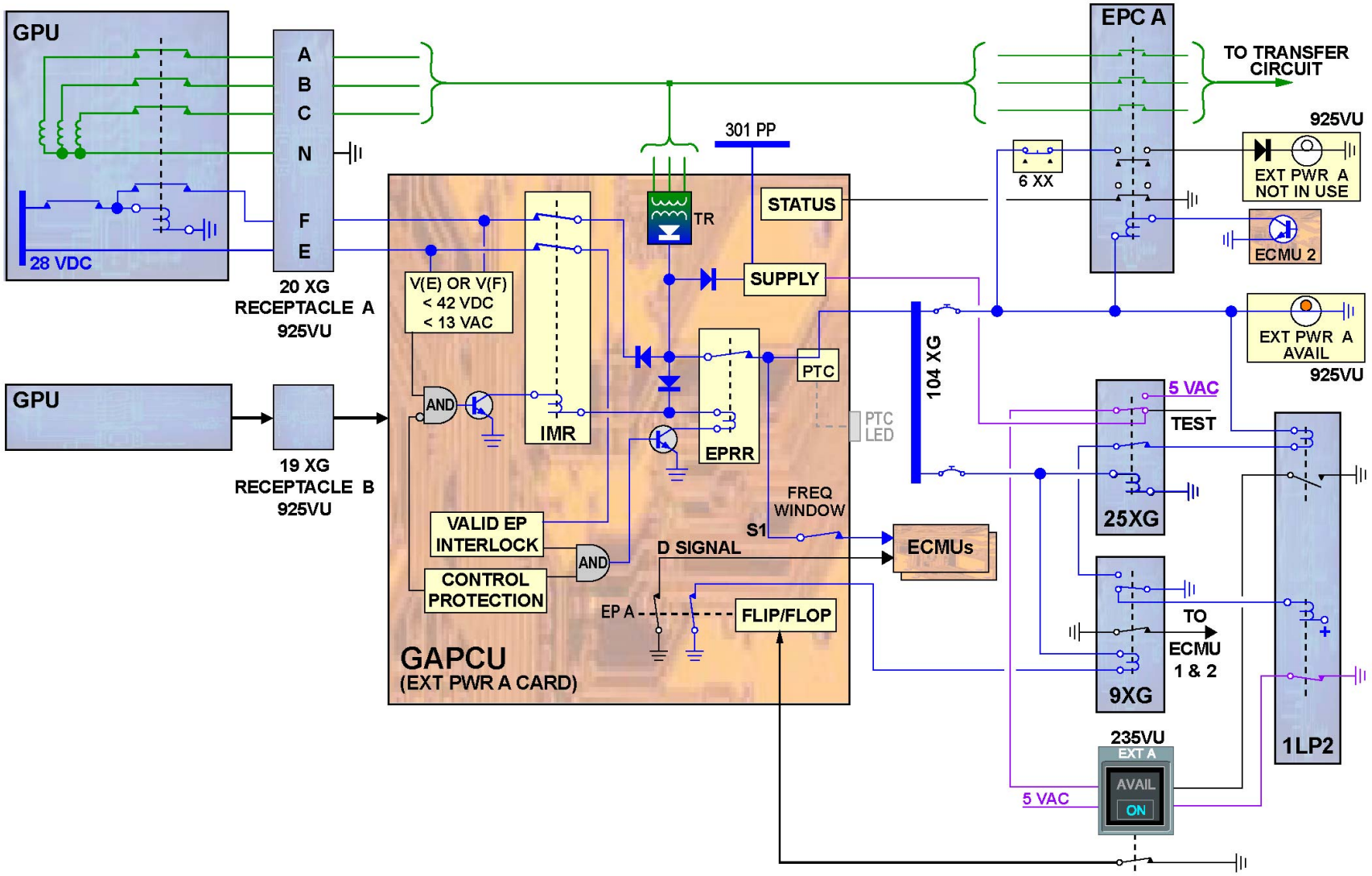

EXTERNAL POWER - NORMAL OPERATION - EXT PWR ON

AUXILIARY AC GENERATION D/O (3)

EXTERNAL POWER (continued)

ABNORMAL OPERATION

An internal feature called the Positive Temperature Circuit (PTC) protects bus bar 104XG.
This PTC will act as a protective circuit, reacting by heat dissipation to any sensed overcurrent.
In case of protection activation (overcurrent detection), the PTC activates the PTC LED and de-energizes busbar 104XG. The function is self-reset when the over current condition no longer exists.
In the event of total GAPCU internal failure, with total loss of the control and protections, a back-up control module ensures the following basic functions, while the aircraft is on ground and EXT PWR A is connected:
- cabin lighting operation for the passenger disembarking,
- ground service systems availability (eg: cargo loading system,...).

The BACK UP module enables the GAPCU to operate in downgraded operating mode.
The BACK UP mode is only valid for EXT PWR A.

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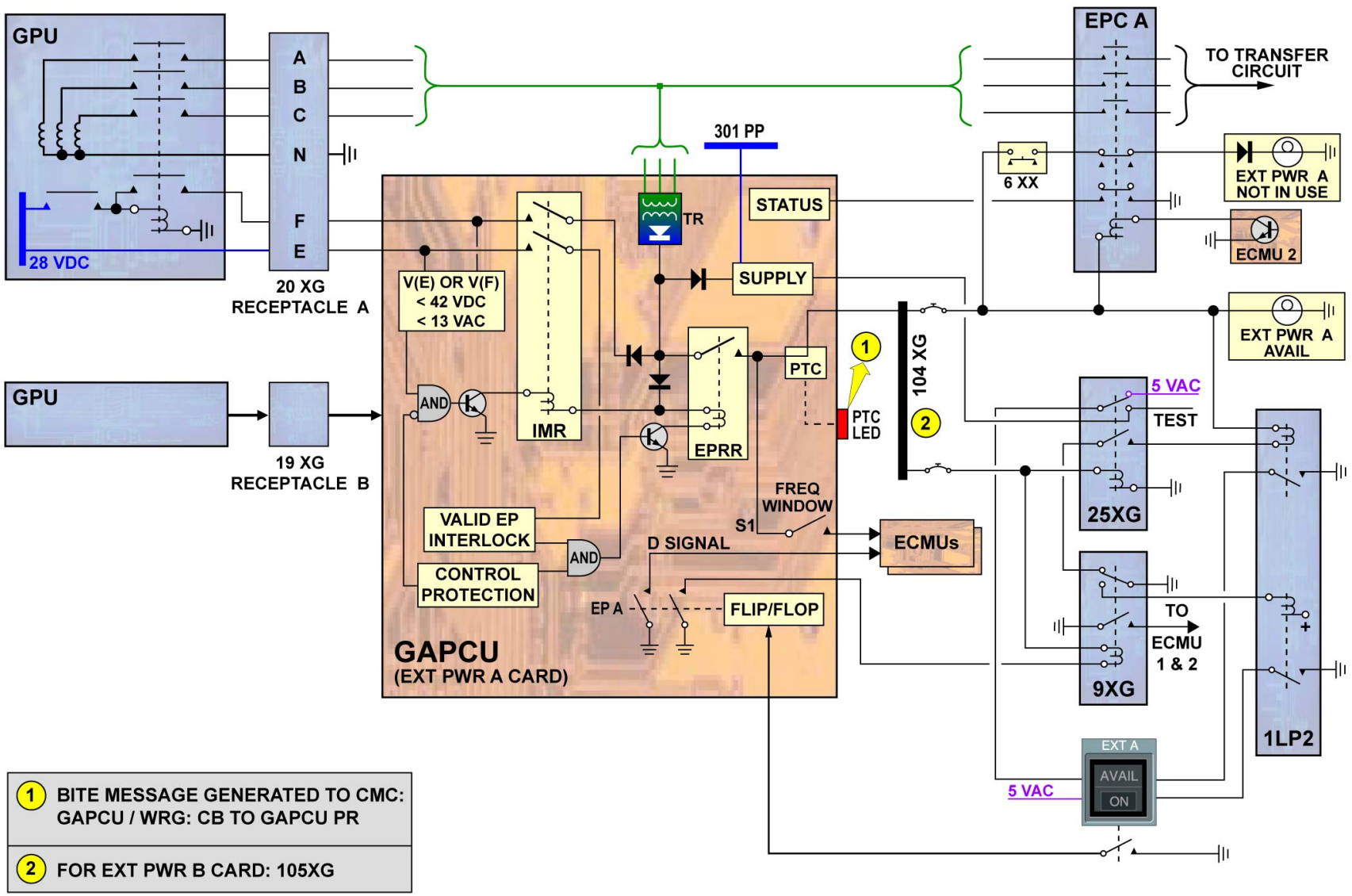

EXTERNAL POWER - ABNORMAL OPERATION

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EMERGENCY AC GENERATION D/O (3)

GENERAL

The AC emergency generation system is used to restore the power supply to the AC and DC ESSential network in case of loss of AC main buses. When main AC buses are lost. This is called the emergency electrical power configuration.

NOTE: For A340, the main AC buses are AC bus 1-1 and AC bus 2-4. For A330, the main AC buses are AC bus 1 and AC bus 2.

CSM/G

The Constant Speed Motor Generator (CSM/G) consists of a hydraulic motor that drives an 115 V, 400 Hz, 3 phase AC GENerator.
The CSM/G is powered by the Green Hydraulic System that is normally pressurized by the engine driven hydraulic pumps or by the Ram Air Turbine (RAT). Engine 1 and 4 pumps pressurize the Green Hydraulic System for the A340. Engine 1 and 2 pumps pressurize it for A330.

CSM/G GCU

The CSM/G is controlled and monitored by the CSM/G Generator Control Unit (GCU), and provides the AC power to the AC ESS network and DC power through the ESS Transformer Rectifier (TR) to the DC ESS network.

CONTROL AND LOGIC

The CSM/G can be started manually or automatically. The supply logic differs according to the CSM/G supply and the aircraft configuration.

AUTOMATIC CONTROL

The CSM/G is automatically started when the two main AC buses are lost. As soon as AC main busbars are lost (contactor 3XC / AC ESSential Bus Switching Contactor is de-energized), the start up sequence is initiated by the generation of a DC signal (discrete) from the CSM/G control logic to the GCU.
The CSM/G is then supplied by the green hydraulic system and begins to run.
When the nominal CSM/G voltage and frequency are reached, the CSM/G GCU closes the EMERgency Generator Line Contactor (EMER GLC - 2XE) to connect the CSM/G to the AC and DC ESS network.

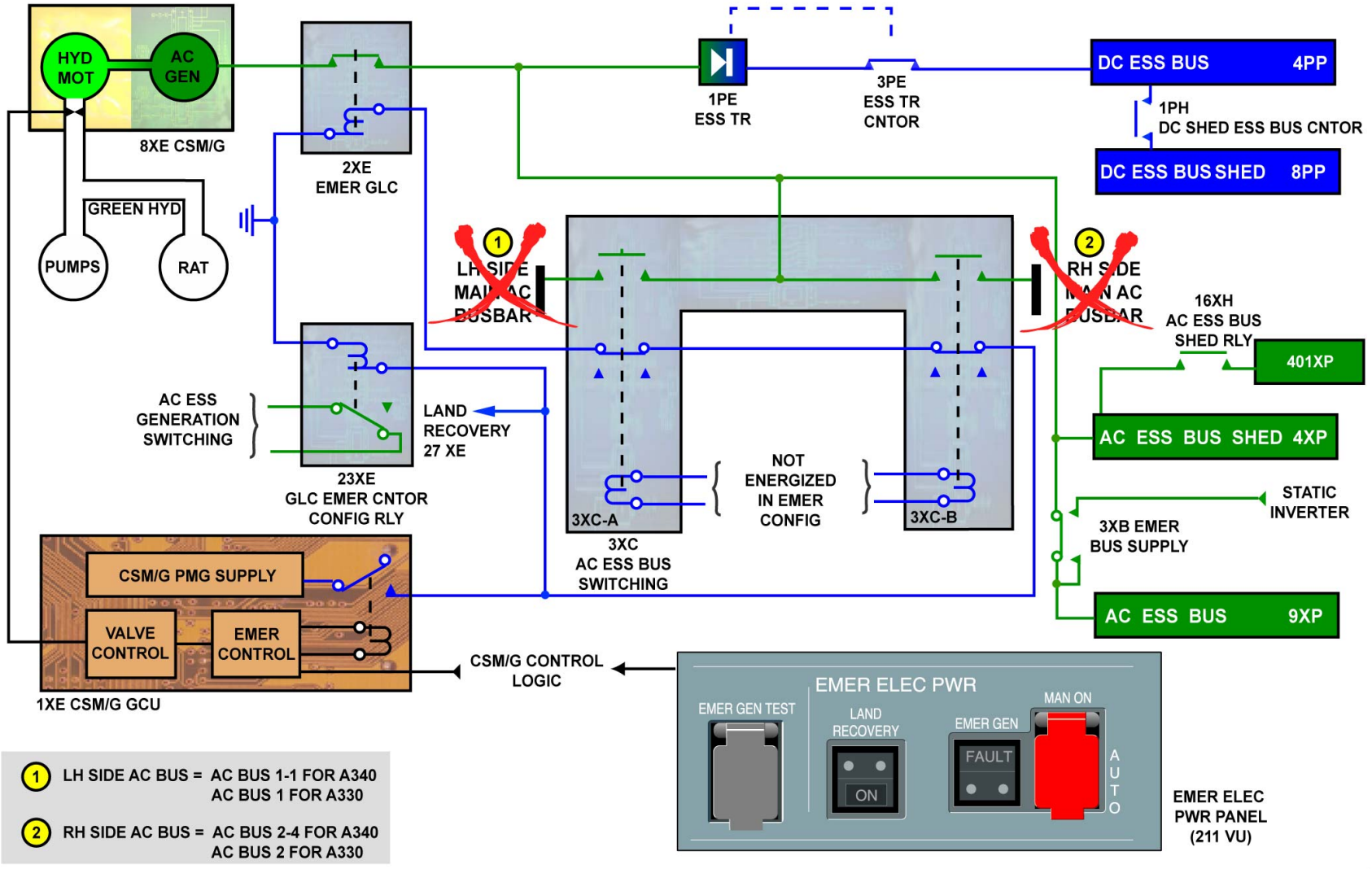
SUPPLY LOGIC

When the CSM/G is powered by either engine driven green system hydraulic pump, it remains operating until the end of the flight.
When the CSM/G is powered by the RAT hydraulic pump, the electrical load is automatically reduced.
The reduction of the electrical load is accomplished by the opening of the contactor 16XH for AC ESS BUS SHEDdable 401XP and contactor 1PH for the DC ESS BUS SHED 8PP to remove power to these busses. The CSM/G stops when the slats are extended.
When the CSM/G stops due to slat extension, the two main BATteries supply the DC ESS BUS 4PP and, via the STATic INVerter, the AC ESS BUS 9XP until the end of the flight.

MANUAL CONTROL

If the automatic control fails, the CSM/G can be manually started by depressing the momentary MANual ON P/BSW located on the EMERgency ELECtrical PoWeR panel on panel 211VU. When CSM/G is manually started, it has priority over on the other main AC sources (GENs, APU GEN...) on the AC and DC ESS network.

G9409341 - GAUT0T0 - FM24D3000000002



GENERAL & CONTROL AND LOGIC

G9409341 - GAUT0T0 - FM24D3000000002

EMERGENCY AC GENERATION D/O (3)

CSM/G

The CSM/G is composed of a Constant Speed hydraulic Motor (CSM) and an 115 V, 400 Hz, 3 phase AC GENerator.

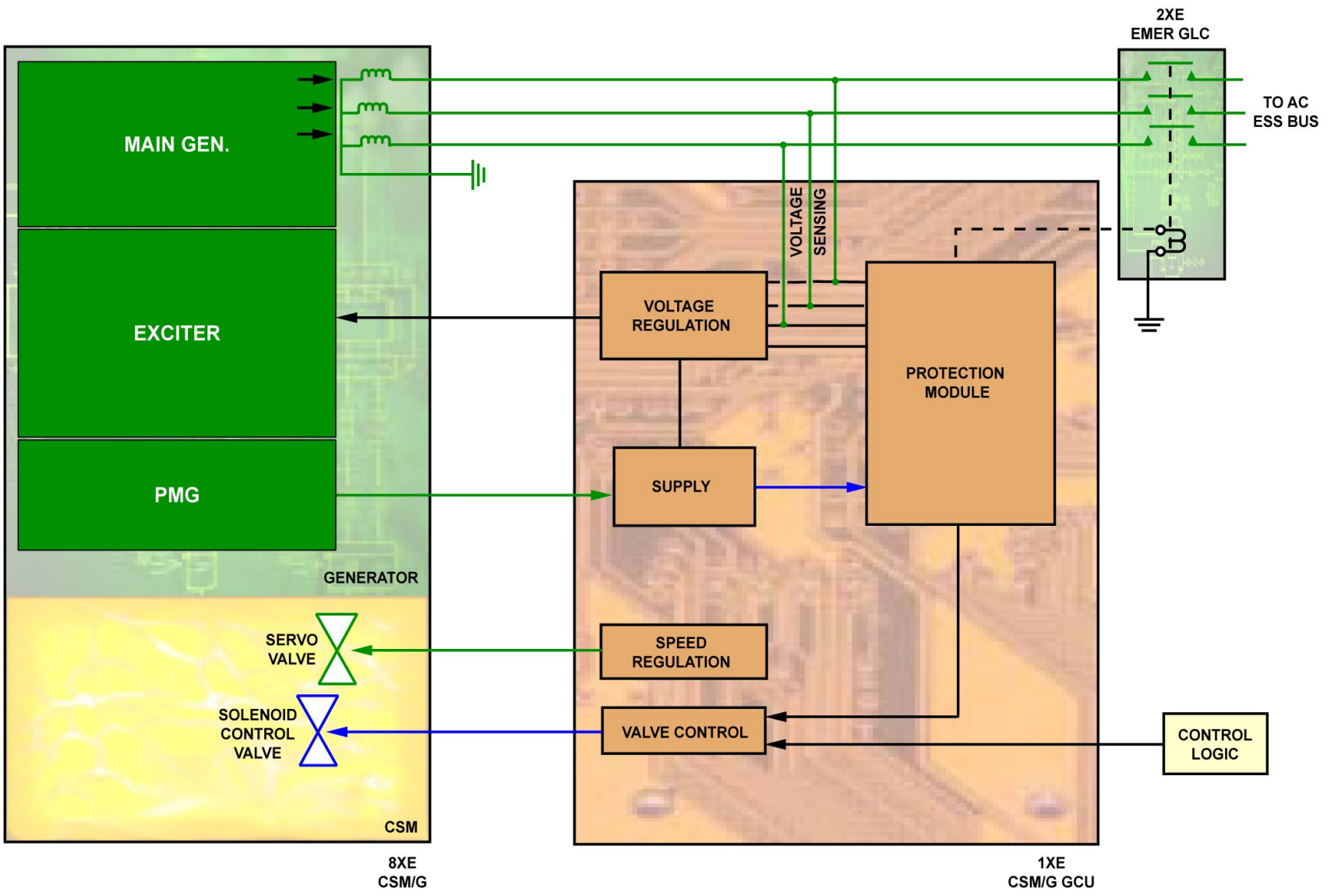
CONSTANT SPEED MOTOR

The CSM is an hydraulic motor that drives a GEN. The CSM is controlled by a solenoid control valve and a servo valve.
The solenoid control valve allows the hydraulic power to run the CSM. It is also used for the hydraulic power isolation (shutoff valve) from the CSM when not used and to stop the CSM/G in the event of failure detected by the GCU protection module.
The servo valve is controlled by the CSM/G GCU speed regulation circuit and regulates the flow of the Green hydraulic fluid to maintain a constant speed for the EMER GEN.

AC GENERATOR

The AC Generator consists of three stages:
- a main generator,
- an exciter,
- a Permanent Magnet Generator (PMG).

G9409341 - GAUT0T0 - FM24D3000000002



CSM/G - CONSTANT SPEED MOTOR & AC GENERATOR

G9409341 - GAUT0T0 - FM24D3000000002

EMERGENCY AC GENERATION D/O (3)

CSM/G (continued)

AUTOMATIC CSMG START AND MAN START

The CSM/G is automatically started when the two main AC buses are lost; the aircraft is in flight (Nose Landing Gear not compressed) and the HOT BATTERY BUS 701PP is supplied. A DC signal (discrete) is sent to the CSM/G control circuit of the CSM/G GCU.
If the automatic start fails, the CSM/G can be started manually by pressing the momentary red guarded MAN ON P/BSW located on the overhead EMER ELEC PWR control panel on panel 211VU.
Note that if the MAN ON P/BSW is pressed in normal configuration (normal AC and DC electrical network powered), the CSM/G starts and is connected to the AC and DC ESS network due to the priority of the CSM/G on the AC and DC ESS network. The CSM/G will operate until shutdown of ENG's 1 and 2 for A330 (N2 <50%), or of ENG's 1 and 4 for A340 (N2 <50%).

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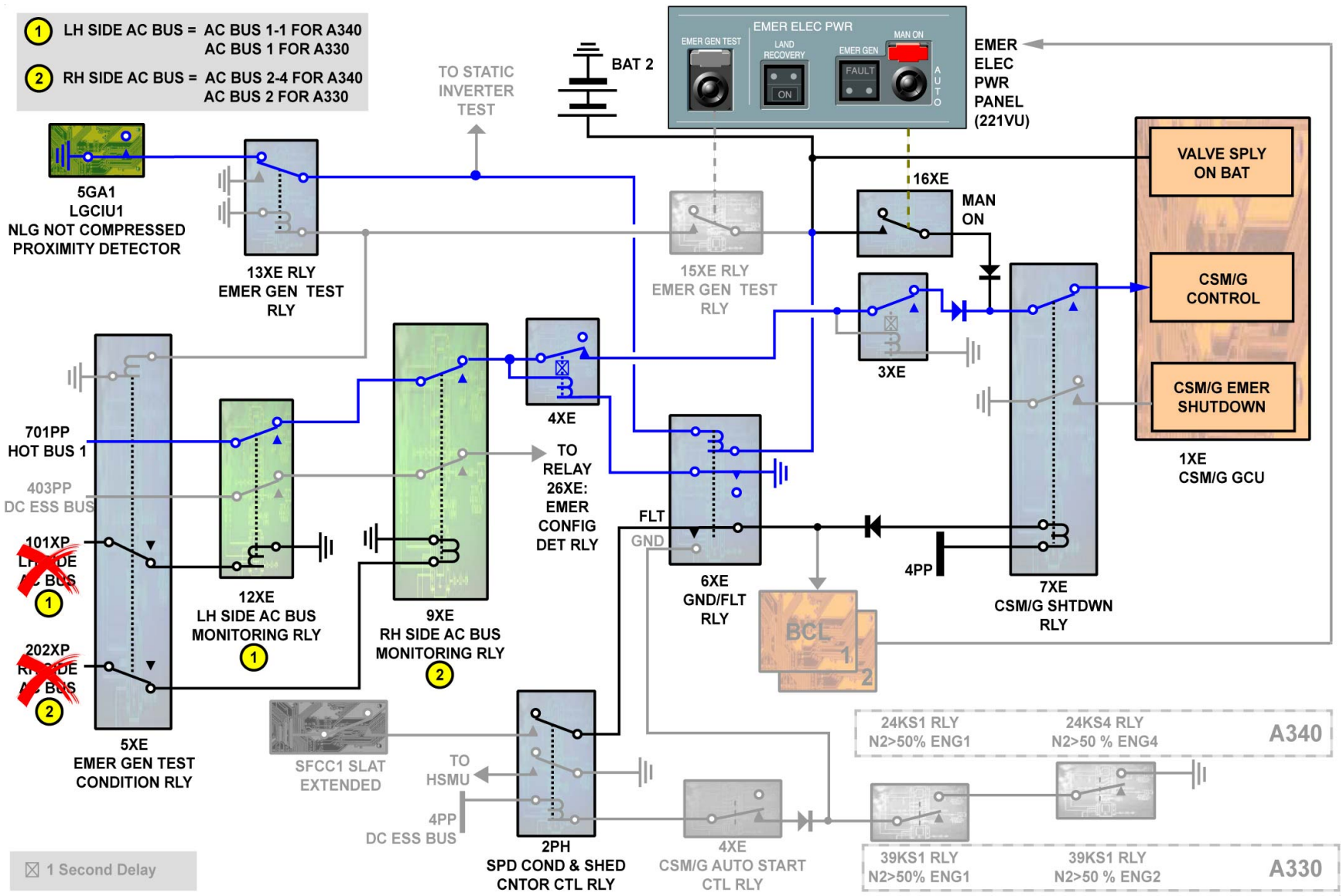

CSM/G - AUTOMATIC CSMG START AND MAN START

G9409341 - GAUT0T0 - FM24D3000000002

EMERGENCY AC GENERATION D/O (3)

CSM/G (continued)

CSMG SHUTDOWN ON GND ENGINES OFF

After landing, with the CSM/G not supplied by the RAT, the CSM/G is switched off as soon as both ENG's N2 are < 50% (ENG's 1 and 2 for A330, 1 and 4 for A340).
The shutdown signal is also sent to the EMERgency ELECtrical PoWeR panel on the overhead panel, the EMER GEN FAULT light comes on.
Relay 26XE (EMER PWR SuPpLY) provides an electrical power emergency configuration signal to:
- the cargo compartment ventilating and heating system,
- the emergency lighting system,
the navigation system (VOR 1 or ADF 1 avail on Digital Distance and Radio Magnetic Indicator (DDRMI)).

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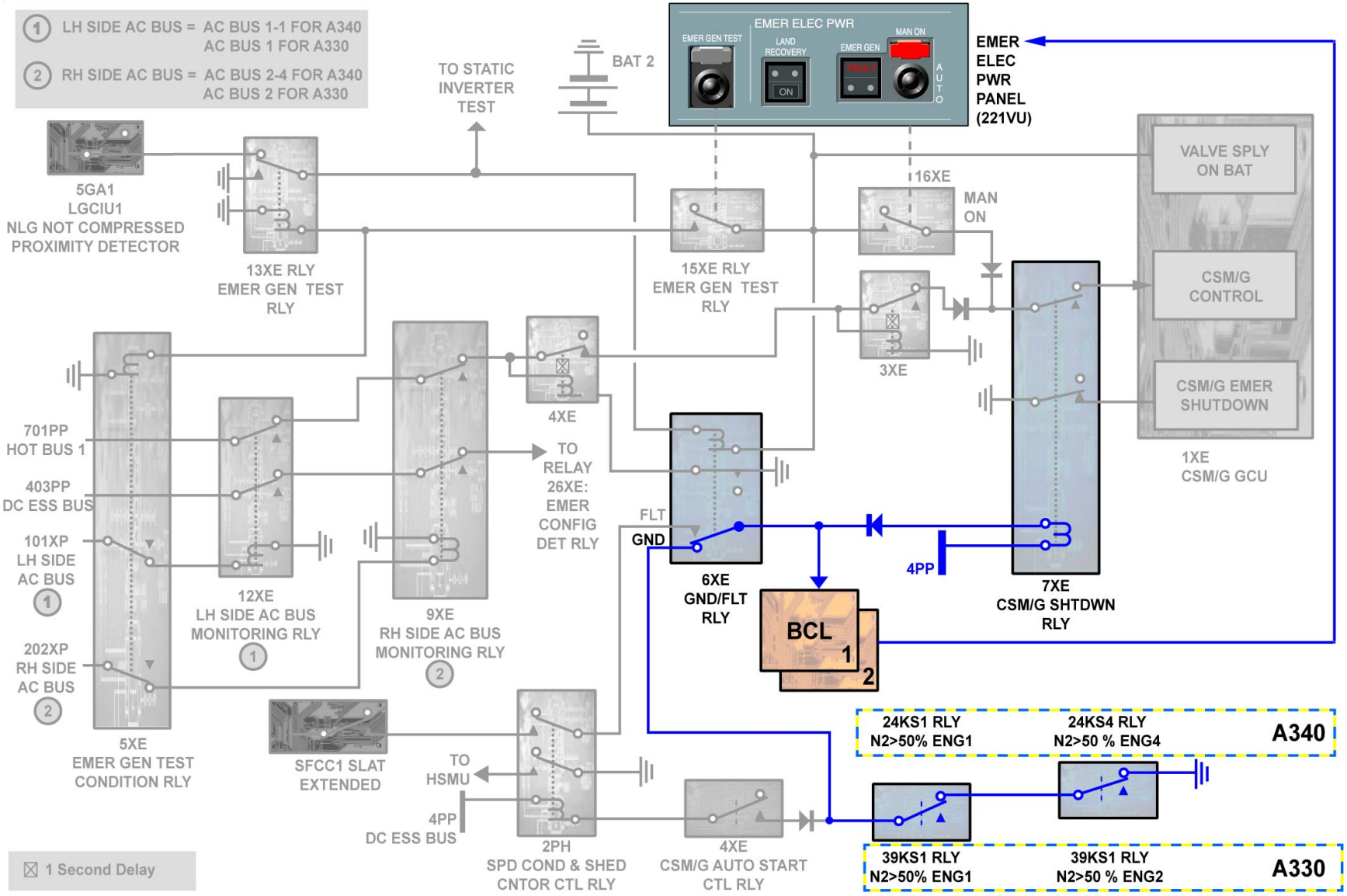

CSM/G - CSMG SHUTDOWN ON GND ENGINES OFF

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EMERGENCY AC GENERATION D/O (3)

CSM/G (continued)

RAT EXTENSION UNTIL SLATS EXTENDED CSMG OPS

The control logic circuit of the Hydraulic System Monitoring Unit (HSMU) performs the RAT extension depending on the following parameters:
- type of A/C (A330 or A340),
- flight conditions,
- when A/C speed is above 100 kts.

If the CSM/G is supplied by an engine driven green system hydraulic pump (determined by ENG's 1 and 2 N2 > 50% for A330, ENG's1 and 4 N2 > 50% for A340), the CSM/G supplies the AC and DC ESS network until ENGs' are shutdown (N2 < 50%). If the RAT is supplying green system hydraulics and the slats are extended, the Slats and Flaps Control Computer (SFCC) provides a discrete signal by closing relay 7XE (CSM/G SHuTDoWN ReLaY), which supplies a ground to the CSM/G GCU EMER shutdown and removes the CSM/G control discrete, to shutdown the CSM/G by closing the solenoid valve of the CSM/G.

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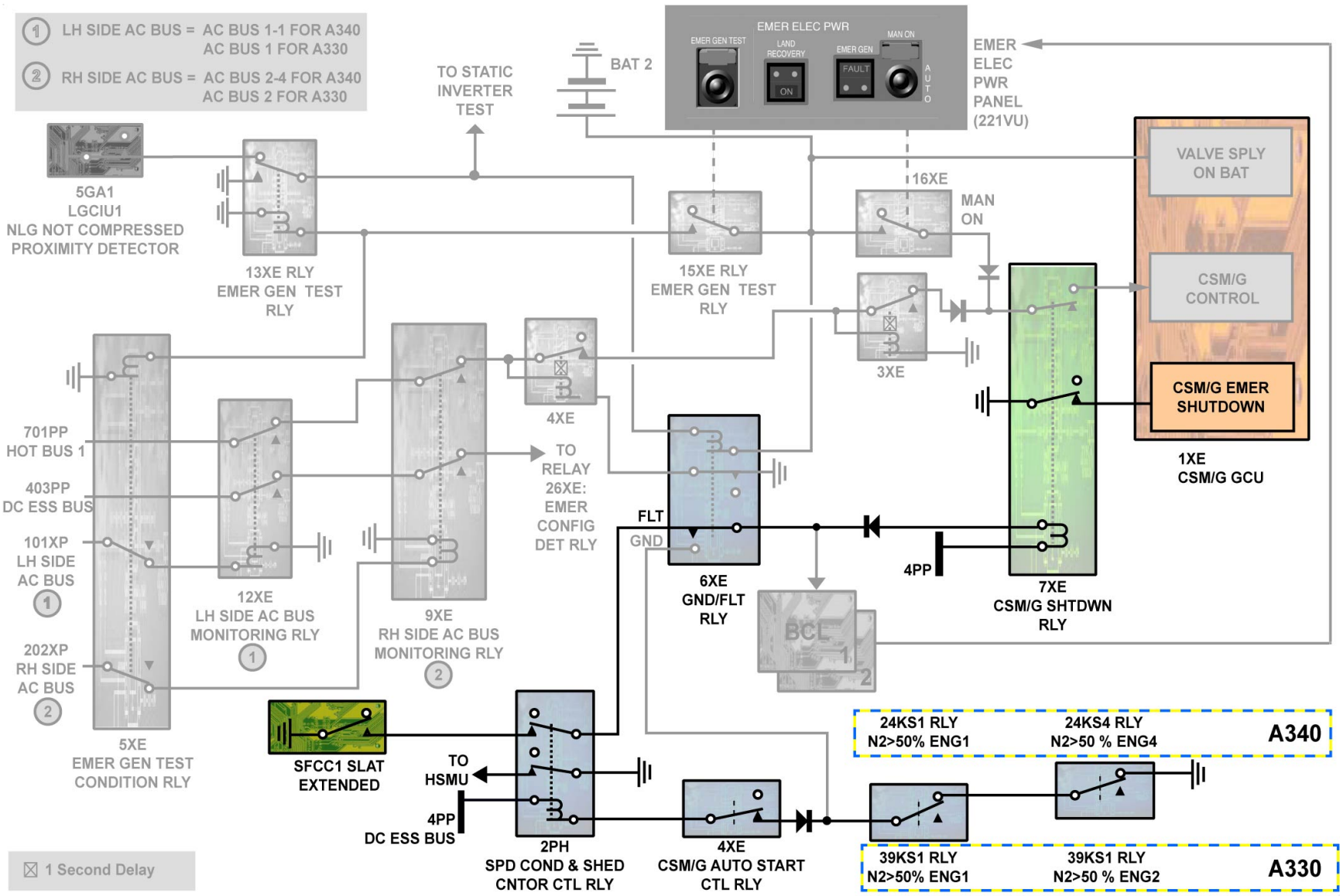

CSM/G - RAT EXTENSION UNTIL SLATS EXTENDED CSMG OPS

G9409341 - GAUT0T0 - FM24D3000000002

EMERGENCY AC GENERATION D/O (3)

CSM/G (continued)

CSMG TEST

To test the EMER GEN on ground, the green hydraulic system must be pressurized by the green electric pump. Then the EMER GEN TEST P/BSW must be pressed and held.
This closes relay 13XE that simulates flight configuration.
Relay 15XE (EMER GEN TEST CONDITION RLY) is energized to simulate loss of AC BUS 1 and AC BUS 2 for A330, of AC BUS 1-1 and AC BUS 2-4 for A340.
Relay 6XE (GND/FLT RLY) is energized (flight configuration).
Note: slats must be retracted.
The CSM/G control circuit is activated, as long as the EMER GEN test P/BSW is pressed in and held, the EMER GEN operates and is connected to the AC and DC ESS network. The operation of the EMER GEN and the connection to the AC and DC ESS network is observed on the AC ELEC ECAM page.
During the test, the RAT extension signal is inhibited by the HSMU.

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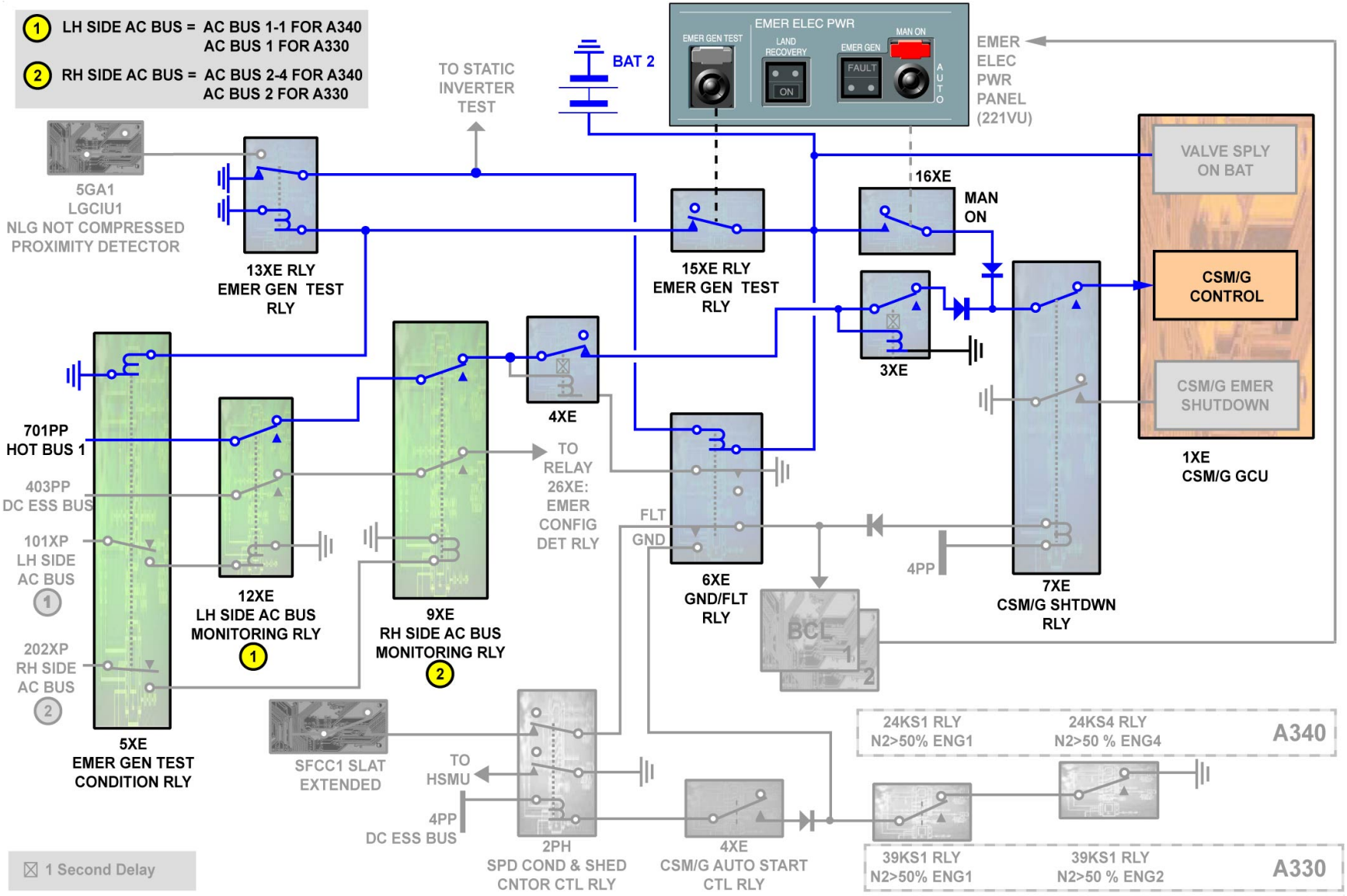

CSM/G - CSMG TEST

G9409341 - GAUT0T0 - FM24D3000000002

EMERGENCY AC GENERATION D/O (3)

COMPONENT STATIC INVERTER

The objective of this topic is to describe the operation, monitoring and test of the STATic INVerter.

NORMAL CONFIGURATION

The STAT INV converts the direct current from the BATs into a single phase alternating current. The STAT INV is not operational as long as the ESS network is supplied from normal AC power or EMER GEN power.

NOTE: Notice the STAT INV supplies only the AC ESS BUS.
The STAT INV only operates on ground, when the BATs are the only power supply source with the BAT1 and BAT2 P/BSWs pressed in.
The STAT INV only operates in flight, when no AC source is available (AC buses and CSM/G not available).
These are the main electrical characteristics of the STAT INV:
- Power: 2.5 KVA,
- Frequency: 400 Hz,
- Voltage: 115 V,
- Phase: 1.

EMERGENCY CONFIGURATION

In EMER configuration (AC buses not available), the STAT INV operates automatically in the following cases:
- when the CSM/G is not available (at slat extension with RAT extended) and the aircraft speed above 50 Kts,
- at landing with aircraft speed lower than 50 Kts and both BAT1 and BAT2 P/BSW's pressed in and CSM/G not available.

MONITORING

The parameters (400 Hz and 115 V) of the STAT INV are displayed on the ECAM ELEC AC page. The STAT INV is monitored for:
- fan failure,
- Overheat: temperature higher than 110 ºC,
- output Over Voltage: voltage higher than or equal to 130+/- 1.5 V,
- output Under Voltage: voltage lower than or equal to 100+/- 4 V,
- output Under / Over Frequency 400 Hz +/- 80 Hz (only for A330).

In case of failure, the STAT INV generates a signal for the System Data Acquisition Concentrators (SDACs), which generates a STAT INV FAULT amber caution message on the ECAM E/WD.
Notice that in case of output over voltage, overheat or 28 VDC BAT supply not present, the STAT INV will not operate. However, the STAT INV will continue to operate with an under frequency or over frequency output, under voltage output or a fan failure.

TEST

The following conditions are required to perform a STAT INV test:
- all main AC buses not supplied,
- BAT P/BSW's (235VU) in OFF position,
- green hydraulic system not pressurized (to prevent CSM/G starting).

To perform the STAT INV test, the EMER GEN TEST P/BSW (15XE on 211VU) must be pressed and held in. This simulates "aircraft in flight" condition.
Under these conditions, the contactors 2PC (CoNTactOR ESS BUS/STAT INV SPLY) and 3PC (CNTOR ESS BUS/STAT INV SPLY) are closed and the BATs 1 and 2 are directly connected in parallel to the STAT INV and also to the DC ESS BUS.
The STAT INV parameters have to be checked on the ECAM AC ELEC page.

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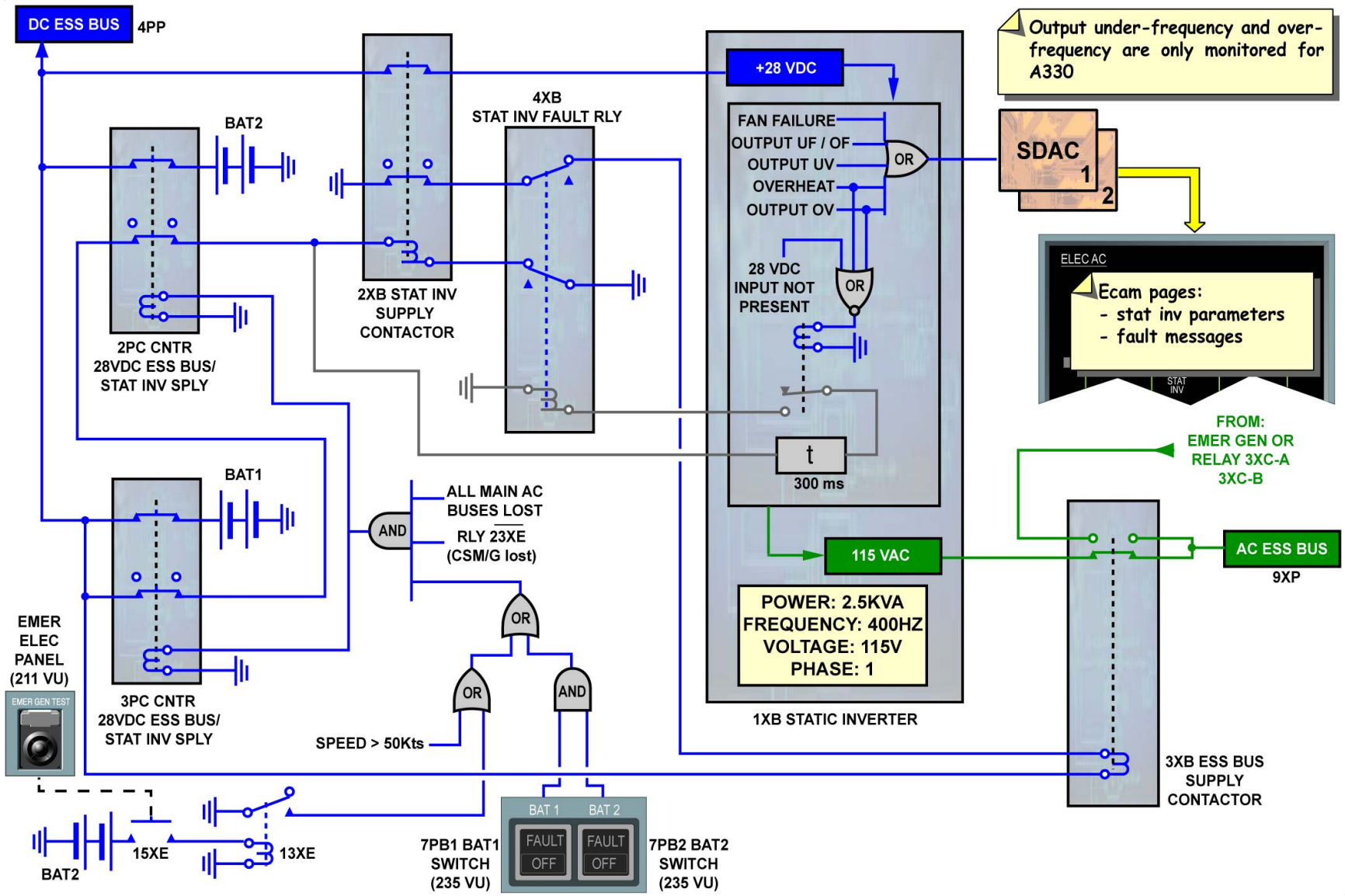

COMPONENT STATIC INVERTER - NORMAL CONFIGURATION ... TEST

G9409341 - GAUT0T0 - FM24D3000000002

EMERGENCY AC GENERATION D/O (3)

AC ESSENTIAL GENERATION SWITCHING

This topic presents the supply and interfaces of the AC ESS generation switching.

NORMAL SUPPLY AND INTERFACES

Contactor 3XC-A (AC ESS BUS SWiTchinG CNTOR) is energized under several conditions:
- LH side main AC busbar is supplied (AC BUS 1 for A330, AC BUS 1-1 for A340),
- 3XC-B (AC ESS BUS SWTG CNTOR) is in de-energized position (EMER GEN not operative),
- relay 23XE (EMER GLC CNTOR CONFIG RLY) and contactor 2XE (EMER GLC CNTOR) not energized (EMER GEN not operative),
- AC ESS FEED P/BSW (4XC on panel 235VU) in normal position (pressed in).

The status of AC ESS BUS SWITCHING contactors 3XC-A and 3XC-B ,the position of the AC ESS FEED P/BSW (4XC) and the AC source supplying the AC ESS network are sent to the SDACs for display on the AC ELEC ECAM page.

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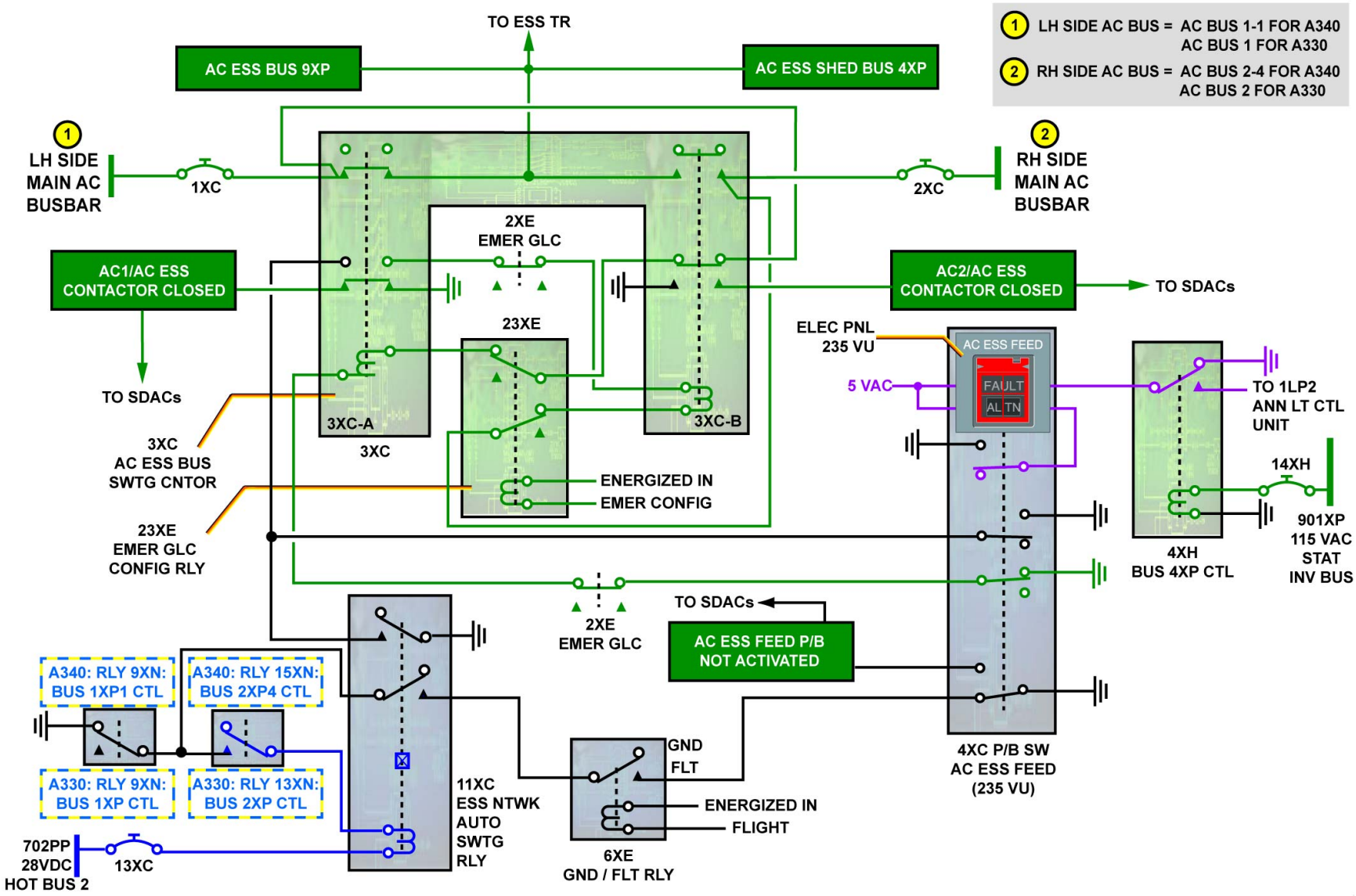

AC ESSENTIAL GENERATION SWITCHING - NORMAL SUPPLY AND INTERFACES

G9409341 - GAUT0T0 - FM24D3000000002

EMERGENCY AC GENERATION D/O (3)

AC ESSENTIAL GENERATION SWITCHING (continued)

ABNORMAL AUTOMATIC SUPPLY

Automatic switching is performed in flight and on ground if the AC ESS FEED P/BSW (4XC on panel 235VU) is pressed in (normal position).
As soon as LH side main AC bus (AC BUS 1 for A330, AC BUS 1-1 for A340) is not supplied, the following events occur:
- contactor 3XC-A opens and the relay 9XN (BUS 1XP-A330 ConTroL RLY ; BUS 1XP1-A340 CTL RLY) opens,
- provided RH side main AC bus (AC BUS 2 for A330, AC BUS 2-4 for A340) is supplied:
- relay 15XN (BUS 2XP - A330 CTL RLY: BUS 2XP4 - A340 CTL RLY) is supplied,
- relay 11XC (ESS NeTWorK AUTO SWTG RLY) is energized,
- relay 3XC-B is energized.

The AC ESS network is recovered automatically from RH side main AC bus (AC BUS 2 for A330, AC BUS 2-4 for A340).
In flight, relay 6XE (GND/FLT RLY) is energized. Relay 11XC (ESS NTWK AUTO SWTG RLY) is self-grounded through contactor 15XN (BUS 2XP4 CTL RLY) for A340, 13XN (BUS 2XP CTL RLY) for A330. If the LH side main AC bus is recovered, the supply to ESS network remains on RH side main AC bus as long as the AC ESS FEED P/BSW 4XC on panel 235VU is not cycled (released out and pushed back in). If the AC ESS FEED P/BSW 4XC on panel 235VU is cycled, the feed for AC ESS BUS will switch back to the LH side main bus (AC BUS 1 - A330; AC BUS 1-1 - A340).
On the ground with relay 6XE (GND/FLT RLY) de-energized, if the LH side main AC bus is recovered, it will automatically switch back to the LH side main AC BUS to take over the supply to the AC ESS network.

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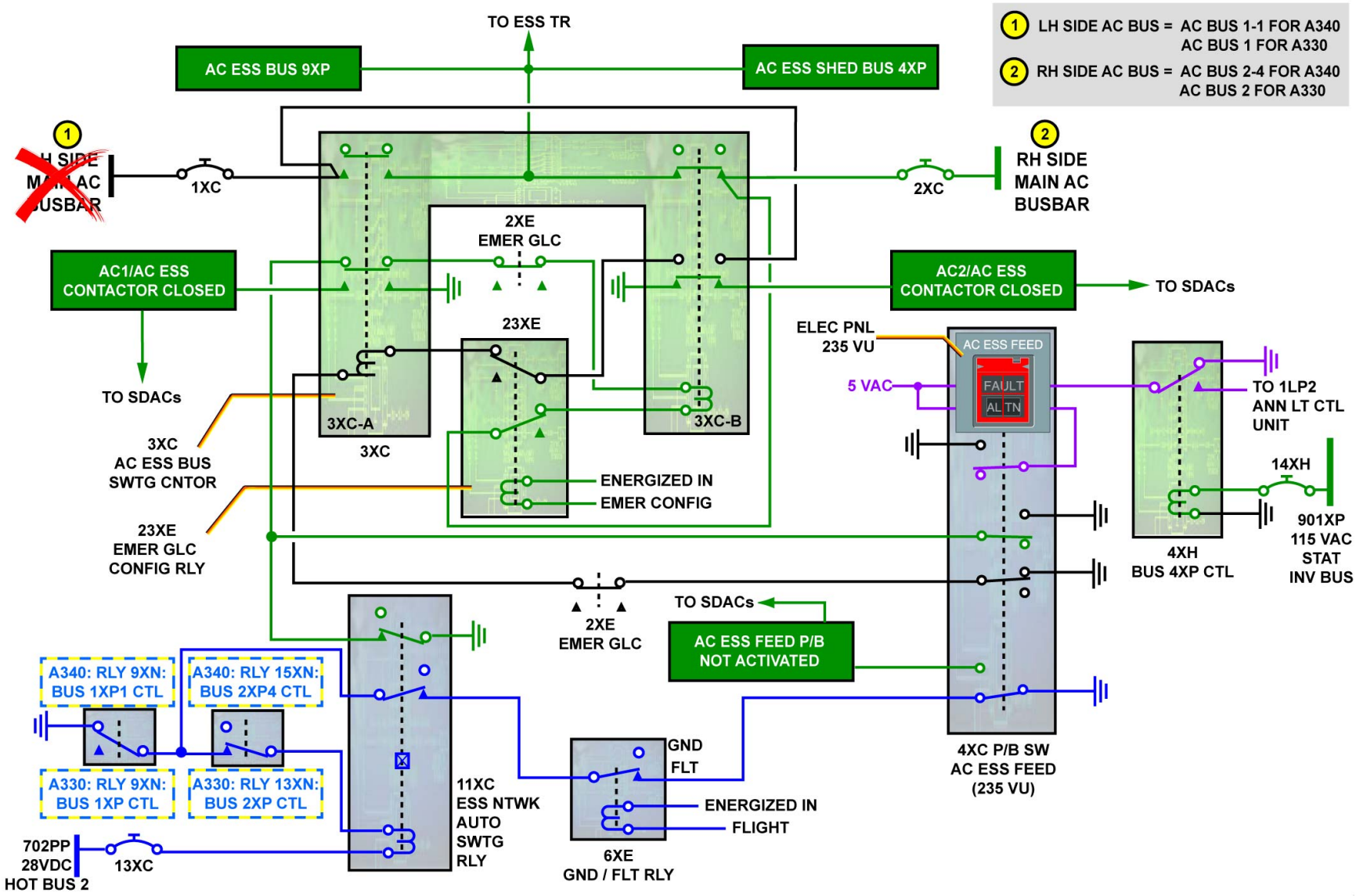

AC ESSENTIAL GENERATION SWITCHING - ABNORMAL AUTOMATIC SUPPLY

G9409341 - GAUT0T0 - FM24D3000000002

EMERGENCY AC GENERATION D/O (3)

AC ESSENTIAL GENERATION SWITCHING (continued)

ABNORMAL MANUAL SUPPLY

In case of automatic switching failure, the FAULT legend on the AC ESS FEED P/BSW (4XC on 235VU) remains on.
The AC ESS FEED P/BSW (4XC on 235VU) has to be released out to perform manual switching:
- ALTN legend comes on white on the AC ESS FEED P/BSW (4XC),
- a ground is connected to close 3XC-B,
- as soon as 3XC-B is closed, the ESS network is recovered from RH side main AC busbar (AC BUS 2 - A330; AC BUS 2-4 - A340).

The FAULT legend on the AC ESS FEED P/BSW (4XC) goes off.

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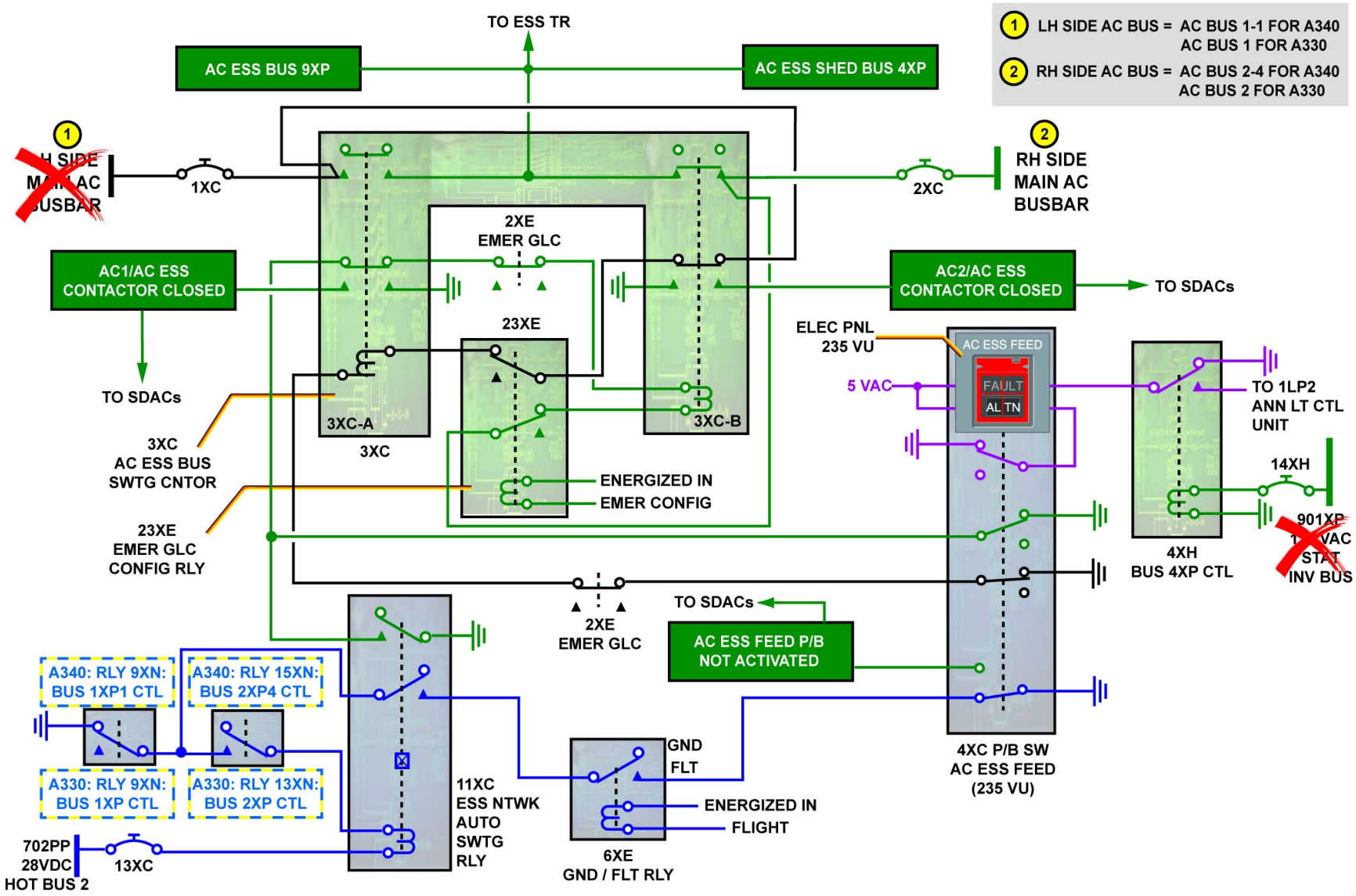

AC ESSENTIAL GENERATION SWITCHING - ABNORMAL MANUAL SUPPLY

G9409341 - GAUT0T0 - FM24D3000000002

EMERGENCY AC GENERATION D/O (3)

AC ESSENTIAL GENERATION SWITCHING (continued)

AC ESS EMER GEN SUPPLY

If the CSM/G (EMER GEN 8XE) is running, relay 23XE (EMER GLC CNTOR CONFIG RLY) is energized as soon as the CSM/G GCU (1XE) closes contactor 2XE (EMER GLC). RLY 23XE gives the emergency generator priority to supply the AC ESS network.

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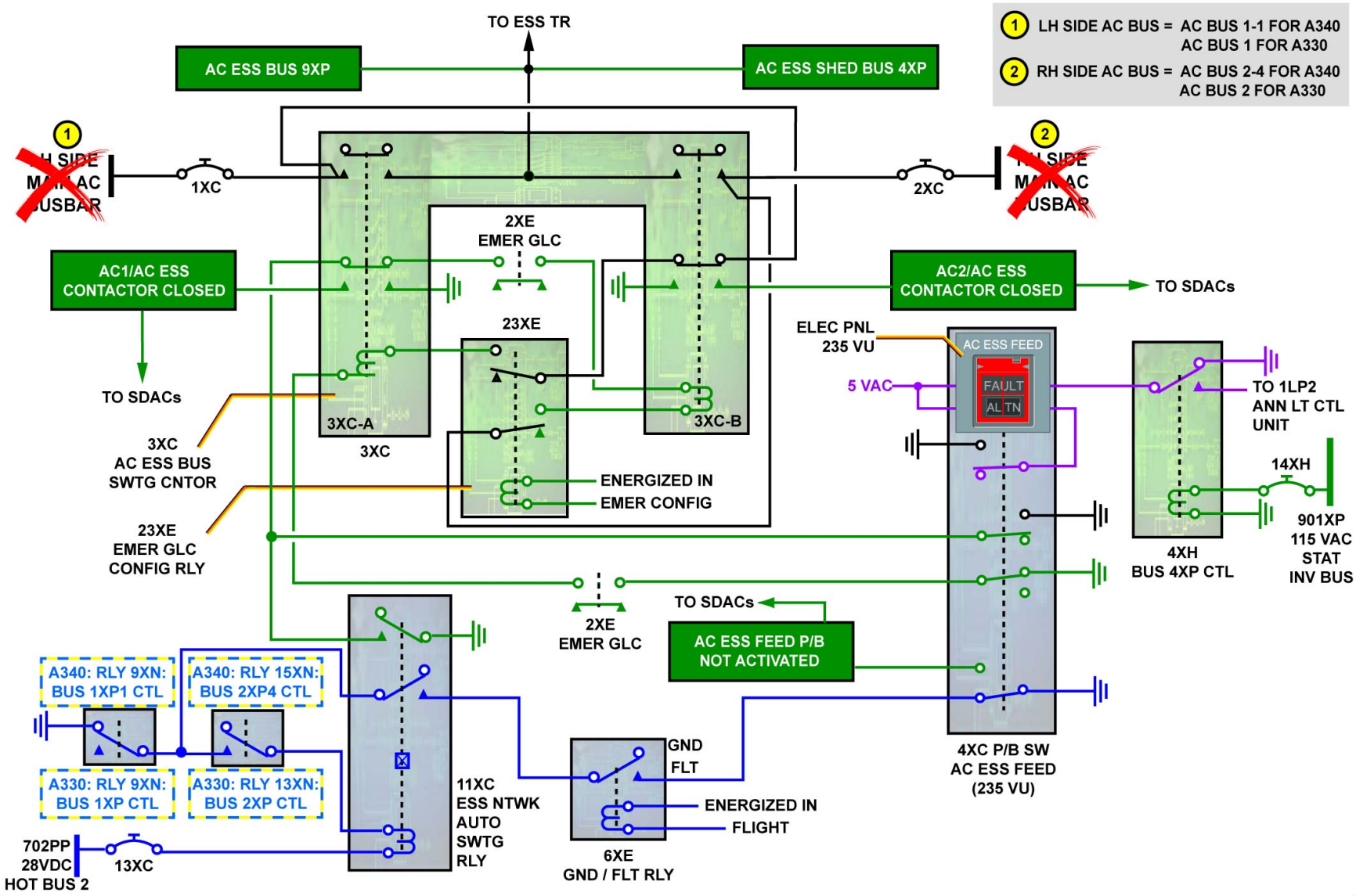

AC ESSENTIAL GENERATION SWITCHING - AC ESS EMER GEN SUPPLY

G9409341 - GAUT0T0 - FM24D3000000002

CONTACTORS MANAGEMENT D/O (3)

GENERAL

The Electrical Contactor Management System (ECMS) uses two computers, called Electrical Contactor Management Units (ECMUs), which serve to control:
- the AC GENerator Line Contactors (GLCs),
- the AC transfer contactors [Bus Tie Contactors (BTC-1 and BTC-2) and the System Isolation Contactor (SIC)],
- the EXTernal PoWeR Contactors A and B (EPC-A and EPC-B) and APU GEN Line Contactors (APU GLC),
- the galley Remote Control Circuit Breakers (RCCBs),
- the flight / ground buses (service buses) RCCBs,
- the DC BUS contactors 1 and 2.

The control of the contactors is automatically performed by ECMU 1 and ECMU 2 to ensure the supply of electrical network from the AC sources (ENG GENs, APU GEN or EXT PWR) corresponding to a priority logic. This priority logic is established by the ECMUs.
The AC transfer contactors (BTC-1, BTC-2 and the SIC) can also be opened manually via the BUS TIE P/BSW (13XU on 235VU).
The galley supply and the flight/ground buses (service buses) supply are controlled by RCCBs that are automatically controlled by the ECMUs or manually controlled through the ECMUs.
Manual control of the galley RCCBs is achieved via the GALLEY P/BSW (1XA on 235VU) and COMMERCIAL P/BSW (22XN on 235VU).
Manual control of the flight/ground buses (service buses) RCCBs is achieved via the COMMERCIAL P/BSW (22XN on 235VU).
The DC BUSES status is monitored by the ECMUs to automatically control the DC BUS CONTACTORS 1 and 2, to ensure supply of the DC BUSES.
The ECMS authorizes and supervises the No Break Power Transfer (NBPT) function to momentarily connect two AC power sources in parallel to create a power transfer with no power transients (bus power interruption). This function is only available on ground.

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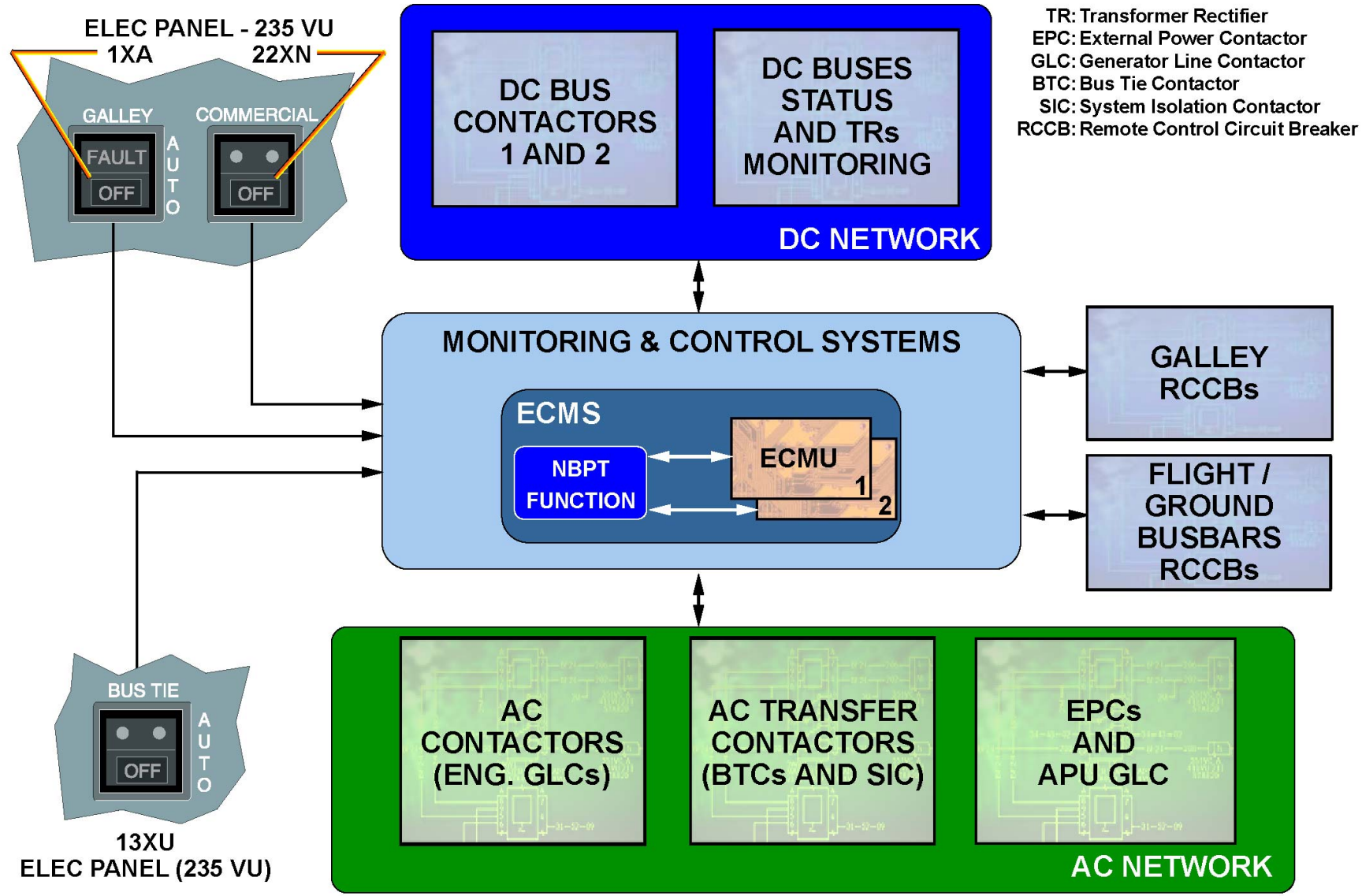

GENERAL

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CONTACTORS MANAGEMENT D/O (3)

CONTACTOR MANAGEMENT DESCRIPTION

Both ECMUs are physically identical and interchangeable. ECMU pin programming identifies:
- installation on side 1 and on side 2,
- installation of options (ex: galley options),
- type of aircraft.

The ECMU is a type 2 system bite.

NOTE: Note: ECMU 1 manages side 1 (left) contactors while ECMU 2 manages side 2 (right) contactors.

POWER SUPPLY

The ECMU power supply depends on the number one or the number two position of the ECMU.
The ECMU 1 is supplied by the BATtery BUS sub-bus 301PP; the DC ESSential BUS sub-bus 401PP and the AC Tie bus 115 VAC.
The ECMU 2 is supplied by the BAT BUS sub-bus 303PP; the DC ESS BUS sub-bus 403PP and the AC Tie bus 115 VAC.
BAT HOT BUSES 701PP and 702PP supply ECMU1 and 2 respectively in the case of ECMU DC ESS BUS and DC BAT BUS supply failure and only when the battery pushbuttons (on 235VU) are selected on (auto position).

GROUND CONTROL LOGIC

The ECMUs interface with Air Data / Inertial Reference Unit 1 (ADIRU 1) and 3, and Landing Gear Control and Interface Unit 1 (LGCIU 1).
LGCIU 1 provides the ground/flight information to both ECMUs.
ADIRU 1 provides the "less than 50 Kts" speed signal to ECMU1 while ADIRU 3 provides the same signal to ECMU 2. This information is used for the NBPT function when the aircraft is on ground and for inhibition of manual BITE functions in flight.

AC CONTACTOR CONTROL

The main AC buses supply (AC BUS 1 and 2 for A330, AC BUS 1-1, 1-2 and 2-3, 2-4 for A340) is controlled by the ECMUs according the priority supply logic. The ECMUs will close or open the various contactors and assign a specific power source to main AC buses (AC BUS 1 and 2 for A330, AC BUS 1-1, 1-2 and 2-3, 2-4 for A340). Note that when the BUS TIE P/B (13XU on 235VU) is in the OFF position, the transfer circuit contactors (BTCs and SIC) are permanently open and electrical power transfer between main AC buses is inhibited.
To control these contactors, the ECMUs receive supply voltage from the AC buses to indicate whether the bus is supplied. Each ECMU also receives the following information:
- the NBPT signals (S1 - synchronization signals and D - NBPT request signals) and the Power Ready status from all Generator Control Units (GCUs) and Ground Auxiliary Power Control Unit (GAPCU) to enable the NBPT function,
- all AC contactors (GLCs, BTCs and SIC) and BUS TIE P/B status for authorizing and supervising the NBPT function, AC power source bus priority to enable AC power source distribution.

AC TRANSFER CIRCUIT

The SIC and the BTCs are automatically controlled by the ECMUs. ECMU1 controls the left hand side of the electrical network and the SIC while ECMU 2 controls the right hand side.
The BUS TIE P/B should be in auto position for normal system operation.
In this position, the SIC and the four BTCs are automatically controlled according to the AC power sources available.
The five contactors open or close according to the priority logic in order to supply the whole AC network.
In the off position, the OFF legend on the BUS TIE P/B comes on. In this case, the SIC and the two BTCs (four BTCs for A340) are permanently open.

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With the BUS TIE P/B selected off, the message "ELEC BUS TIE OFF" is displayed on the ECAM.

CAUTION: Caution: In the case of BUS TIE P/B in OFF position, no external or APU power is possible.

DC CONTACTOR CONTROL

Both ECMUs receive DC contactor status. The DC contactor status is to ensure a correct supply of the DC bus bars when an AC supply connection occurs, according to AC power supply logic.
ECMU 1 receives:
- status of Transformer Rectifier 2 (TR 2) for fault and over current detection. The acquisition of the TR 2 fault and Over current detection is to provide DC bus power transfer with a TR 2 failure or NOT to allow DC bus power transfer if TR 2 is failed due to an over current,
- 28 VDC from TR 1 to supply DC BUS 1, 2 and BAT BUS (BUS 3) through (1PC1 - 28VDC BUS 1/BUS 3 SuPpLY CoNTactOR and 1PC2 - 28VDC BUS 2/BUS 3 SPLY CNTOR) DC BUS power transfer control logic,
- voltage from 101PP (DC BUS 1 sub-bus bar). It is used to indicate DC BUS 1 is supplied.
ECMU 2 receives:
- status of TR 1 for fault and over current detection. The acquisition of the TR 1 fault and over current detection is to provide DC bus power transfer with a TR 1 failure or not to allow DC bus power transfer if TR 1 is failed due to an over current,
- 28 VDC from TR 2 to supply DC BUS 1, 2 and BAT BUS (BUS 3) through (1PC1 - 28VDC BUS 1/BUS 3 SPLY CNTOR and 1PC2 - 28VDC BUS 2/BUS 3 SPLY CNTOR) DC BUS power control logic,
- voltage from 206PP (DC BUS 2 sub-bus bar). It is used to indicate DC BUS 2 is supplied.
A loss of one ECMU does not affect the supply of the main DC buses.

BITE

Each ECMU has one ARINC 429 data link output that permits monitoring data to be sent to the System Data Acquisition Concentrators (SDACs) 1 and 2 for display on the ECAM, and the BITE data to Central Maintenance Computer (CMC). The ECMU communicates to the CMC in two modes:
- the first (normal mode) is a power-up test and fault monitoring / fault recording,
- the second mode (interactive mode) is only possible on ground via the MCDU for a manual test activation and fault display access.
Each ECMU continually monitors its inputs, outputs and internal functions to determine if a failure condition exists. Failure information will be stored in the internal Non-Volatile Memory (NVM) and also sent to the CMC.

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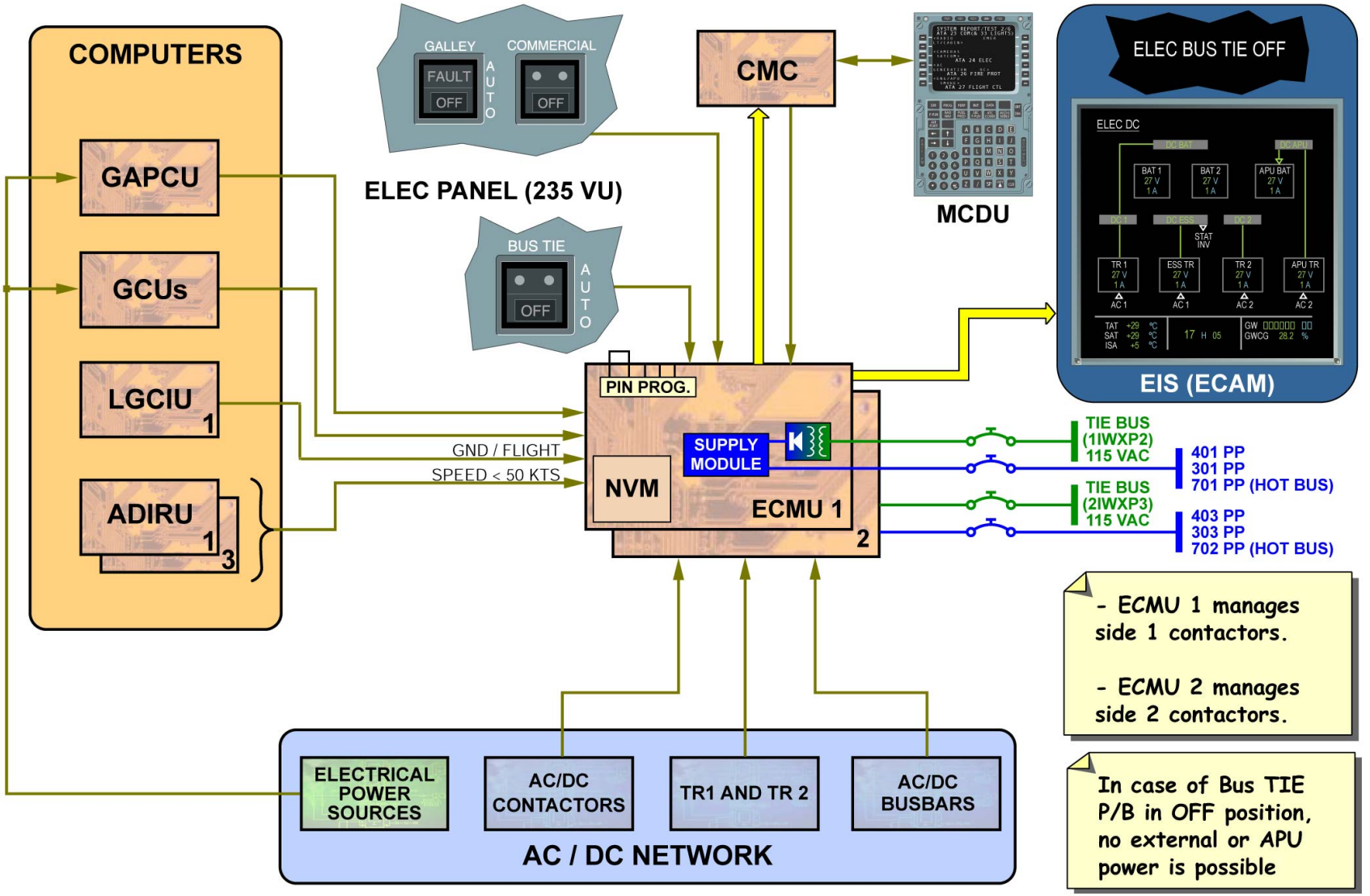

CONTACTOR MANAGEMENT DESCRIPTION - POWER SUPPLY ... BITE

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CONTACTORS MANAGEMENT D/O (3)

CONTACTOR MANAGEMENT DESCRIPTION (continued)

REMOTE CONTROL CIRCUIT BREAKER (RCCB)

The RCCB controls and protects certain AC power distribution lines and certain equipment power supply lines.
The RCCB is used to fulfill the following functions:
- electrical line protection (tripping - circuit breaker function),
- electrical load switching (switching - contactor function).

The status of the main contacts is known by a visual state indication (OPEN or CLOSE) on the front face of the RCCB. The status of the main contacts is also acquired by the ECMUs by the status of two internal auxiliary contacts that move with the main contacts. This auxiliary contact monitoring function of the ECMUs allows the ECMUs to know that the main contacts are OPEN or CLOSED.
In case of tripping (overload or manual trip - circuit breaker function), a trip signal is transmitted to the Circuit Breaker Monitoring Unit (CBMU) and the associated ECMU. The CBMU will list the RCCB on the ECAM C/B page to indicate the opened RCCB and the RCCB's functional designation, Functional Item Number (FIN) and location (see Circuit Breaker Monitoring Description topic).
The RESET P/B located on the front face of the RCCB, has two stable positions:
- when pressed in, electrical control is authorized. On the front face of the RCCB, the visual indication shows the OPEN or CLOSE message in function of the main contact status,
- the RESET P/B is released out, if there is an overload on the main circuit (circuit breaker function). In this case, the RCCB cannot be electrically controlled OPEN or CLOSE. The main contacts are locked in the OPEN status. The TRIP signal switches from the OPEN to the CLOSE status and a signal is sent to the CBMU for display on the ECAM C/B page. On the front face of the RCCB, the visual indication shows the OPEN message. The RESET P/B must be pushed in to reset and reactivate the RCCB control.

The RCCBs are supplied with:
- 115/200 VAC, 400 Hz from the AC Main Distribution bus bars,
- 28 VDC either from the ECMUs or control relays from certain equipment, such as a hydraulic electrical pump, that use an RCCB to control the operation of the equipment.

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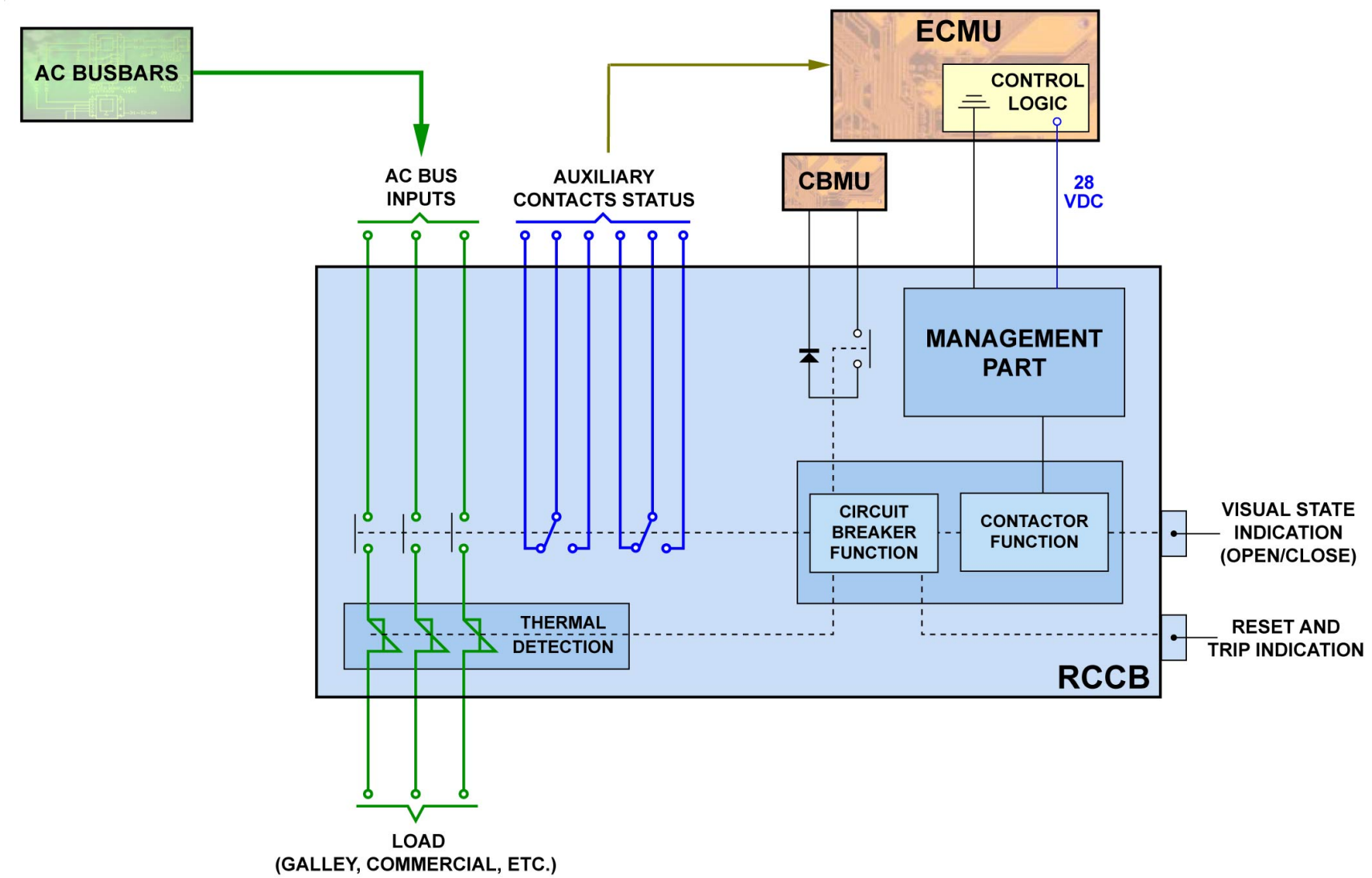

CONTACTOR MANAGEMENT DESCRIPTION - REMOTE CONTROL CIRCUIT BREAKER (RCCB)

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CONTACTORS MANAGEMENT D/O (3)

CONTACTOR MANAGEMENT DESCRIPTION (continued)

GALLEY / COMMERCIAL SUPPLY CONTROL

The galley supply system consists of three-phase feeder lines that supply aircraft terminal blocks with 115/200 VAC, 400 Hz power. The galleys are electrically connected to the terminal blocks through power feeders. The galley assemblies are divided into any parts:
- for A340-300, galley assemblies divided into two parts: forward/middle and aft area,
- for A330, galley assemblies divided into three parts: forward/middle, middle/aft and aft area.

Any galleys and sub-busbars can be automatically shed by ECMUs (via RCCBs) when aircraft is in a degraded electrical power configuration (loss of one IDG in flight without APU GEN for example). This shedding can be performed partially or completely.
The automatic shedding logic is defined in function of:
- the aircraft type (A330 / A340-300),
- the number of available AC sources (IDGs, APU GEN, EXT PWR A and/or B),
- the flight / ground condition,
- the AC source(s) lost and its (their) location(s),
- the AC source in overload condition (if overload condition detection),
- the number of installed galleys.

NOTE: Note: For A330, RCCB 10 is powered via relay 2XA1, whereas for A340-300, RCCB 10 is powered via the specific relay 6XA1.

Each RCCB controls individually and directly the power supply to the connected galleys. It opens the contactors and cuts-off the power supply in case of an overload or a short circuit in the galley (circuit breaker function).
The RCCBs are remotely controlled by ECMUs.

When the GALLEY control P/BSW (1XA on 235VU) is in the OFF position:
- the OFF legend in the GALLEY P/BSW (1XA) comes on,
- GALLEY TOTAL SHEDding ReLaY's (2XA1 and 2XA2 for A330
- 2XA1, 2XA2 and 6XA1 for A340-are de-energized,
- all galleys are OFF,
- the ECAM message GALLEY SHED is displayed on the bottom of the ECAM AC ELectrical page and the message GALLEY is displayed on the ECAM STATUS page under INOPerative SYStem,
- the control logic is reset to enable re-energization of the GALLEY power supplies by pushing the GALLEY P/BSW (1XA) in.

When the COMMERCIAL control P/BSW (22XN on 235VU) is in the OFF position:
- the OFF legend in the COMMERCIAL P/BSW (22XN) comes on,
- all galleys are OFF,
- in addition to the galleys off, all service buses are OFF.

The equipment on the service buses that are de-energized are:
- passenger entertainment system (music and video if installed),
- cargo loading system,
- electrical service (service outlets),
- escape slide lock mechanism ice protection,
- water/waste (drain mast) ice protection,
- lavatory and cabin lights,
- water heaters,
- in-seat power supply (if installed).

The ECAM message COMMERCIAL OFF is displayed on the bottom of the ECAM AC EL page and the message COMMERCIAL is displayed on the ECAM STATUS page under INOP SYS.
The COMMERCIAL OFF function provides additional manual electrical load shedding, if needed.

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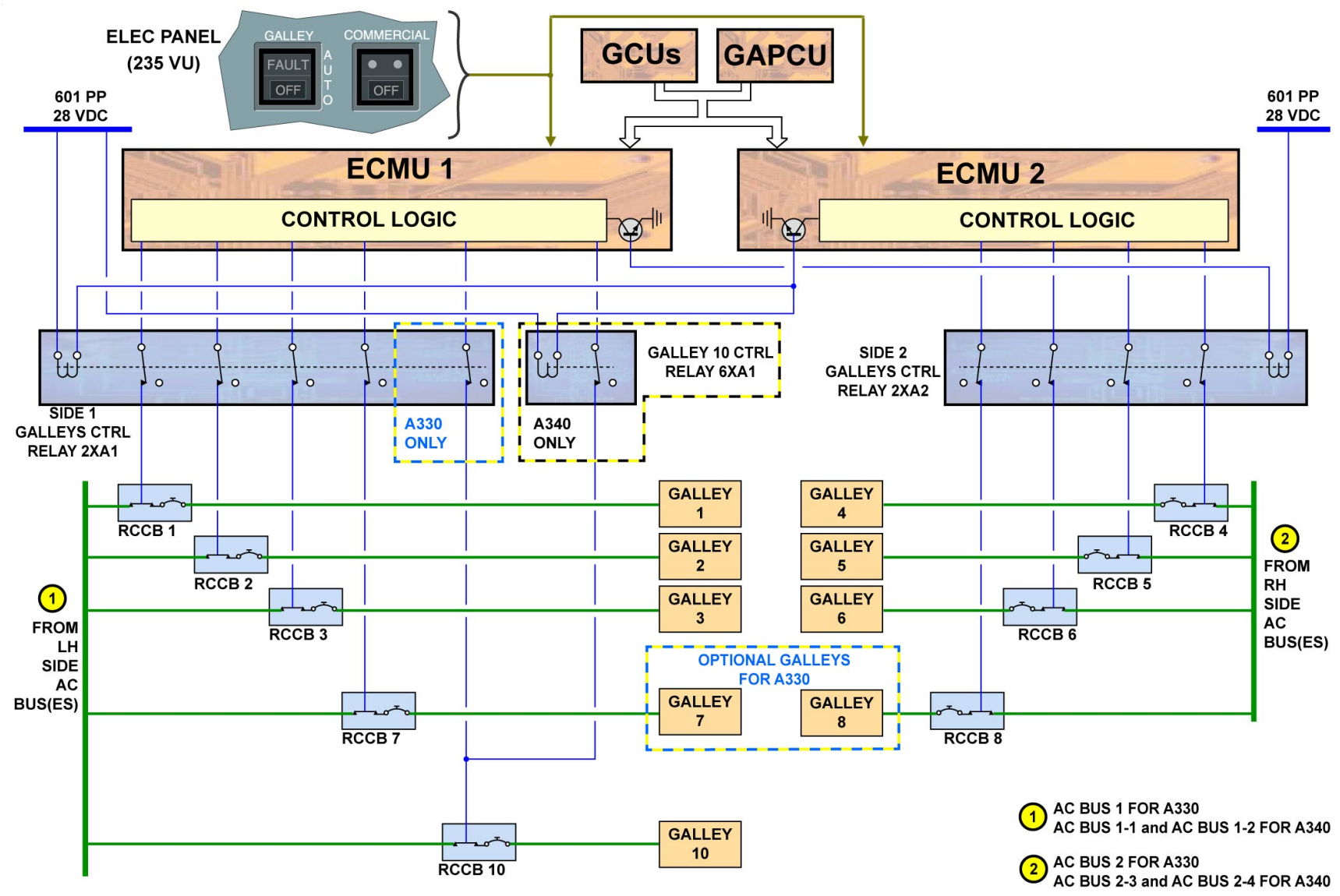

CONTACTOR MANAGEMENT DESCRIPTION - GALLEY / COMMERCIAL SUPPLY CONTROL

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CONTACTORS MANAGEMENT D/O (3)

CONTACTOR MANAGEMENT DESCRIPTION (continued)

SERVICE BUS CONTROL

EXT PWR A supplies AC and DC service buses. ECMU 2 controls the service buses RCCB's via the position of the MAINTENANCE SERVICE BUS selector (toggle) switch (16XX on panel 5001VE located in forward entry area). Once EXT A is available, ECMU 2 will control the associated service buses RCCB's and will allow the service buses to be supplied. The service buses are sub buses of both main AC buses (AC BUS 1 and 2 for A330, AC BUS 1-1 and 2-4 for A340) and include a DC service bus.

ECMU 1 monitors and controls 6XN1 and 7XN1, which are the normal aircraft power RCCB's to supply two AC BUS 1 sub buses for A330, or two AC BUS 1-1 sub buses for A340.

ECMU 2 monitors and controls the sub bus RCCB's 6XN2, 7XN2, 1XX, 2XX, 3XX, 4XX and 6XX contactor.

The RCCB's 6XN2 and 7XN2 are the normal aircraft power RCCB's to supply two AC BUS 2 sub buses for A330, or two AC BUS 2-4 sub buses for A340.

The RCCB's 1XX, 2XX, 3XX, 4XX are the service bus RCCB's that supply the same two sub buses (AC BUS 1 sub buses for A330, AC BUS 1-1 sub buses for A340) supplied by 6XN1 and 7XN1 and the same two sub buses (AC BUS 2 sub buses for A330, AC BUS 2-4 sub buses for A340) supplied by 6XN2 and 7XN2. These are alternate RCCB service bus supplies (1XX, 2XX, 3XX, 4XX) and are used when only ground service from EXT PWR A is selected (used) on the aircraft.

ECMU 2 acquires the position of the MAINT BUS selector switch (16XX on 5001VE) and electro-magnetically holds the MAINT BUS selector switch in the ON position.

ECMU 2 monitors the normal TR 2 supply contactor 2PU.

NOTE: Note: If TR 2 is failed, the service bus supply from the MAINT BUS selector switch (16XX) will not be electro-magnetically held in the ON position by ECMU 2, preventing ground service supply on the aircraft.

The TR 2 is energized through contactor 6XX and is used to supply the DC SERVICE BUS 6PP.

NOTE: Note: Placing the COMMERCIAL P/BSW (22XN on 235VU) to the off position, the services buses will be de-energized. This function is covered in the GALLEY/COMMERCIAL SUPPLY topic (previous topic).

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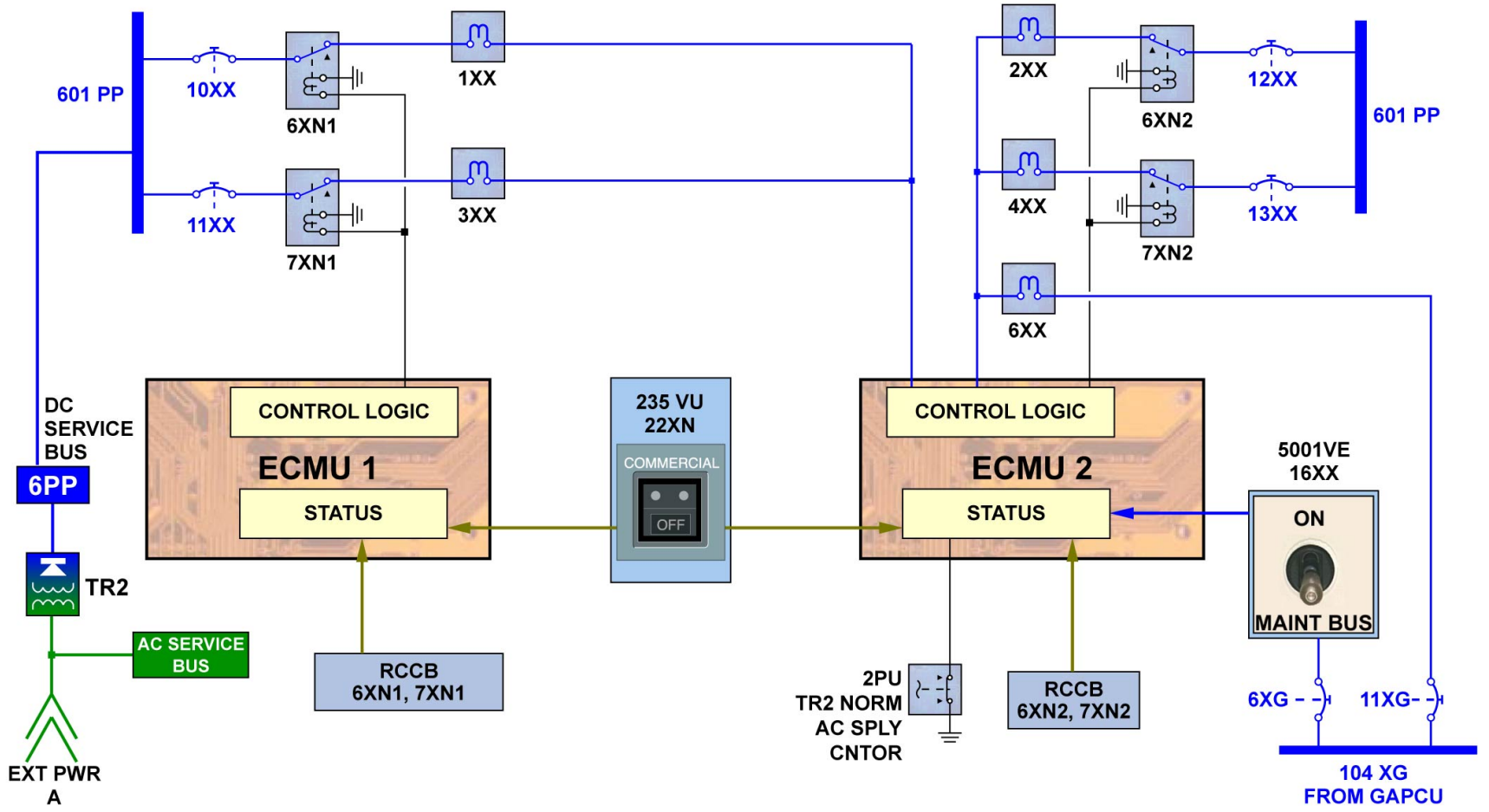

CONTACTOR MANAGEMENT DESCRIPTION - SERVICE BUS CONTROL

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CONTACTORS MANAGEMENT D/O (3)

CIRCUIT BREAKER MONITORING DESCRIPTION: CBMU

The Circuit Breaker Monitoring System (CBMS) consists of one Circuit Breaker Monitoring Unit (CBMU) that monitors the status of the Circuit Breakers (C/Bs) and Remote Control Circuit Breakers (RCCBs).
The CBMS performs the following functions:
- C/B and RCCB monitoring,
- status identification and data transmission,
- monitoring of the open C/Bs for optional equipment.

The C/Bs and RCCBs are arranged by groups of 30 maximum. The CBMU monitors 26 groups on side 1 and 16 groups on side 2.

CIRCUIT BREAKERS STATUS

The CBMU performs a scanning of the C/Bs and RCCBs status through a wiring matrix, by sending a DRIVE signal on the auxiliary contacts of the C/B's and RCCB's.
The RETURN signal informs the CBMU of the status, according to the auxiliary contacts which are open when the main contacts of the C/Bs or RCCBs are closed.
The C/B status can be:
- closed,
- open or,
- unknown, if neither open nor closed position can be confirmed in case of failure.

CIRCUIT BREAKER IDENTIFICATION

The CBMU contains in a NVM, the aircraft circuit breaker database containing the data about all the monitored C/Bs and RCCBs.
The identification of open C/Bs and/or RCCBs is made by designation, panel position and FIN. The open circuit breaker information is viewed on the ECAM C/B page by selecting the C/B P/BSW on the ECAM Control Panel.

SYSTEM OPERATION

As soon as the CBMU is powered up, on ground or in flight, it begins the scanning of all the C/Bs and RCCBs.
The CBMU is supplied from DC busbar 101PP.

CLOSED C/B

When no C/B and/or RCCB are open or tripped, the NORMAL message is displayed on the ECAM C/B page, if the ECAM C/B page is selected using the ECAM control Panel.

OPEN C/B

When the CBMU detects an open or tripped C/B and/or RCCB, its identification is transmitted to the ECAM via the Display Management Computers (DMCs) and Flight Warning Computers (FWCs) and a Class 1 level 2 amber caution is triggered. The Class 1 level 2 amber caution message, ELEC C/B TRIPPED, appears on the ECAM E/WD display. However, the ECAM C/B page is not displayed automatically. To view the C/B and/or RCCB that is opened or tripped, the ECAM C/B page must be selected manually on the ECAM Control Panel.
All data related to the open C/B's and/or RCCBs are stored in a NVM for the BITE function, and also sent to the CMC.
The CBMU also monitors the C/B's in pulled position when corresponding optional equipment is not installed. If one of these C/Bs is detected not pulled, a maintenance message is sent to the CMC.

CBMU DATA BASE

The Multipurpose Disk Drive Unit (MDDU - 1TD) is used only on the ground to perform the up-loading of the C/B database in the CBMU by means of a floppy disk.

NOTE: Note: The C/B database is customized for each aircraft. An ARINC bus 429 enables the automatic transfer between the MDDU (1TD) and the CBMU via the Data Loading Routing Box (DLRB -

102TD) when the Data Loading Selector (DLS -101TD) is selected to CBMU.

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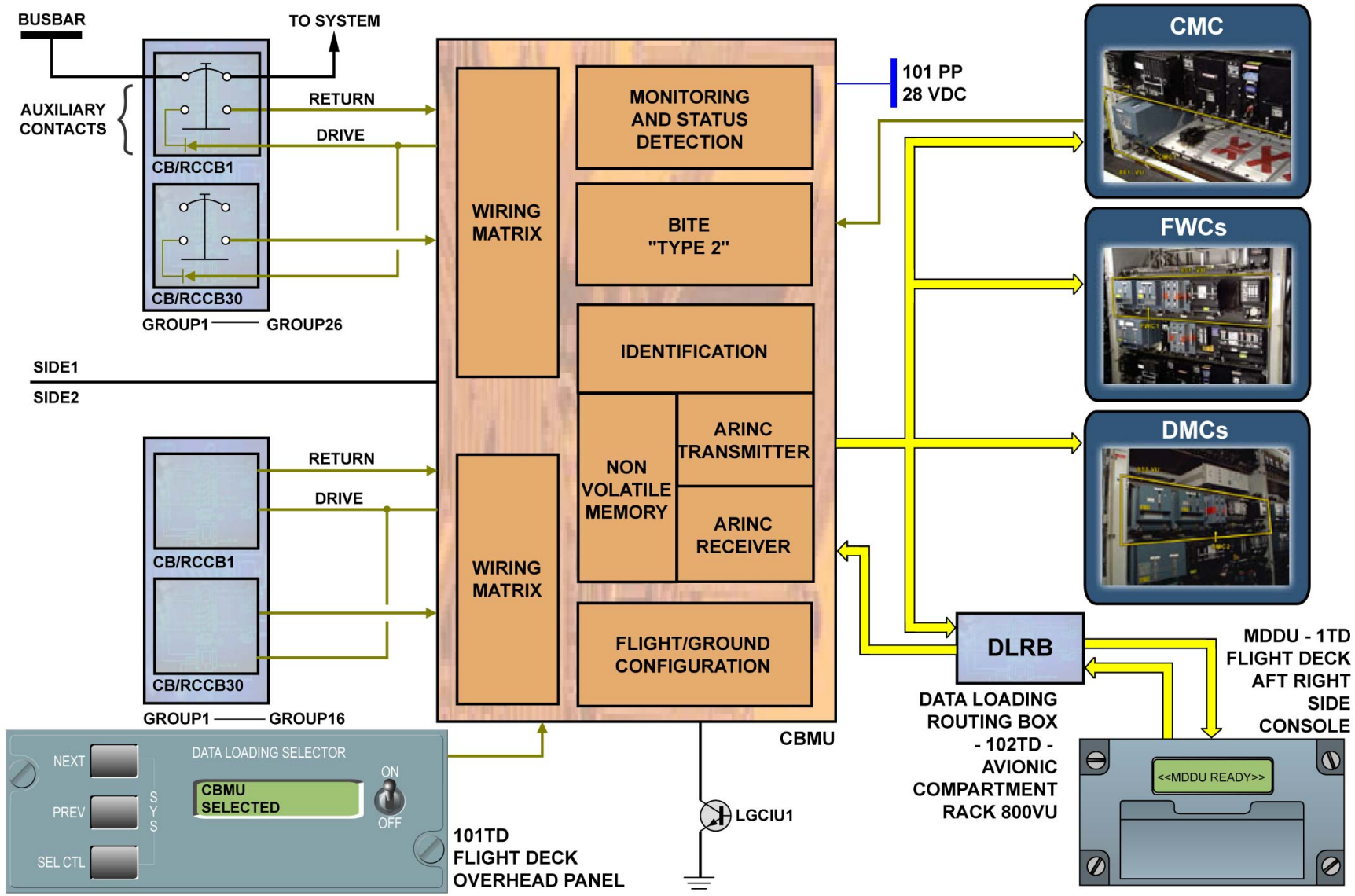

CIRCUIT BREAKER MONITORING DESCRIPTION: CBMU - CIRCUIT BREAKERS STATUS ... CBMU DATA BASE

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CONTACTORS MANAGEMENT D/O (3)

NBPT FUNCTION

The purpose of the NBPT (No-Break Power Transfer) is to avoid any electrical disruption of the busbars in order to prevent unwanted momentary power supply transients. The no break power function will prevent system computer(s) from experiencing long power supply cutoffs, thus preventing the possibility of system computer(s) automatically initiating an unwanted power-up tests.

NOTE: Note: A system computer(s) can only initiate a power-up test on the ground. During the duration of the power-up test, a system computer(s) is inoperable.

The NBPT function is operative on the ground only between two power sources (IDGs, APU GEN, EXT PWR A, EXT PWR B). The electrical supply source (IDGs, APU GEN, EXT PWR A & B) connection/disconnection to the aircraft's electrical network must be performed according to standard operating procedures.
To provide an NBPT function, the 2 ECMUs authorize and supervise the opening and closing of the line contactors (GLCs, APU GLC, EPCs) and the transfer contactors (BTCs and SIC). The GCUs and the GAPCU provide the data necessary for the ECMUs to perform the NBPT function. The NBPT sequence occurs as the ECMUs receive a "request" signal from the GCUs or GAPCU to indicate an AC power source (IDG, APU GEN, EXT PWR A & B) is coming on the electrical network or going off the electrical network. Upon receiving a "request" signal from an AC power source, the ECMUs now look for a "synchronization signal" from the AC power source to indicate the AC power source is synchronized with the reference power source for the respective AC BUS. The synchronization signal enables the momentary paralleling function to be accomplished. This paralleling function is performed in no more than 80 ms. The priority of the reference source is provided by the GAPCU according to what AC power sources are available. Once the AC power source coming on the AC BUS has paralleled and is established on the AC BUS, the ECMUs remove the AC power source going off the AC BUS.

INADVERTENT PARALLELING TRIP

The Inadvertent Paralleling Trip function prevents a sustained paralleling between the various electrical sources (IDG, APU, EXT PWR). If two different sources are connected in parallel on an AC BUS for more than 80 ms, the ECMU opens the applicable contactors (BTC, APU GLC, EPC) to cancel the paralleling. If the paralleling persists (130 ms), the ECMU opens a second contactor. Each time a contactor is open, it is latched in this status until reset occurs. In addition to the Inadvertent Paralleling Trip function in the ECMUs, a back-up Inadvertent Paralleling Trip protection is provided by each GCU and the GAPCU.

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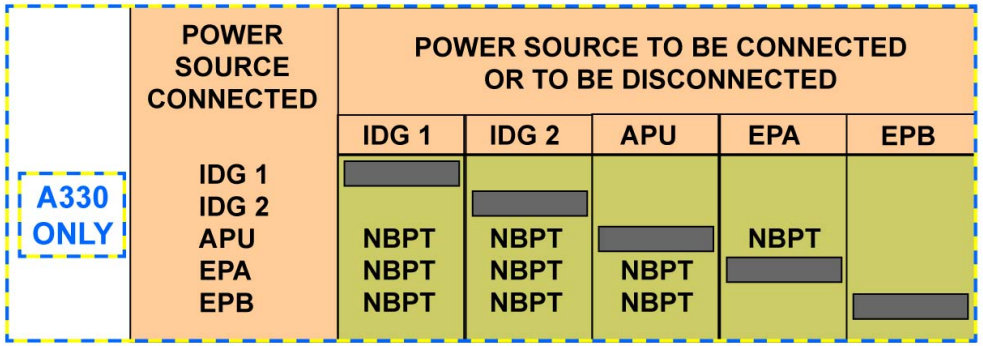
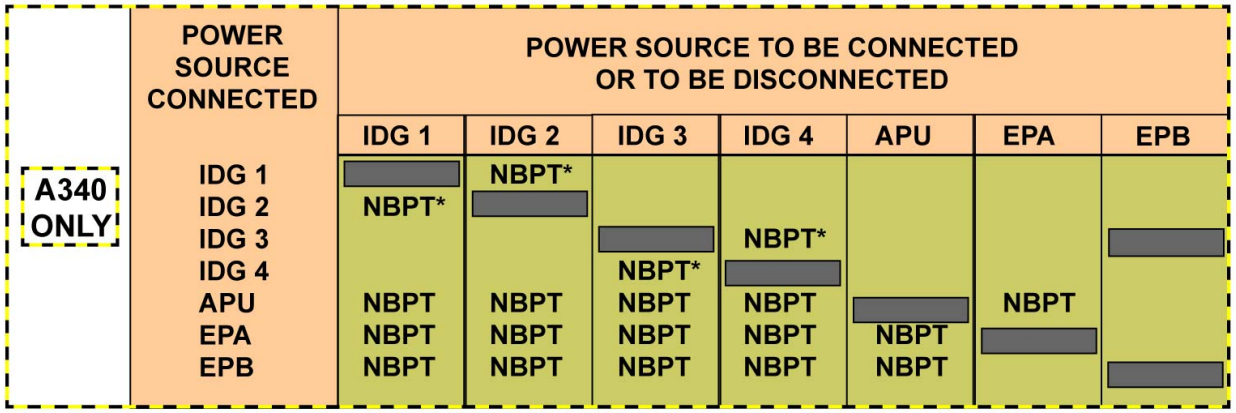


IPT performed as soon as a two sources paralleling occurs longer than 80 ms.



LEGEND

NBPT — NBPT is operative.

NBPT* — NBPT is operative provided that one IDG is connected on the other side, there will be no NBPT across the SIC between LH and RH IDG channels.

NBPT is not operative.

No electrical transfer possible.

NBPT FUNCTION - INADVERTENT PARALLELING TRIP

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CONTACTORS MANAGEMENT D/O (3)

NBPT FUNCTION (continued)

NBPT LINK

In normal operation, on the basis of the data provided by the GCUs, the GAPCU, and the contactor status (OPEN or CLOSE), the ECMUs manage and control the main AC contactors (GLCs, APU GLC, BTCs, EPC A and EPC B and SIC).
The signals involved in the NBPT functions are:

From the GCU to ECMU:

- D: the NBPT request signal, AC source requests connection or removal to an AC BUS,
- S1: established synchronization signal, the ENG GENs and the APU GEN is within +/- 5 VAC, +/- 0.5 HZ, +/- 15 degrees phase angle difference from the reference AC source. This reference is sent to the GCUs from the GAPCU.

NOTE: Note: The reference AC source is established by the GAPCU according to the presently available AC sources.

- This function is called the Frequency Reference Unit (FRU) function inside the GAPCU. The FRU establishes a priority depending upon the available AC power sources and uses the FRU AC power source as the reference for synchronization, only on the ground. The FRU AC reference priority is determined by the AC power source configuration and may or may not be the same reference sent to the left side of the network or to the right side of the network.
- FRU priority:
- EXT PWR A,
- EXT PWR B,
- APU GEN,
- Master 400HZ reference.

FROM THE ECMU TO GAPCU AND GCU:

- S2: indicating the end of the NBPT function.

From the GAPCU to ECMU:

- D: the NBPT request signal, AC source requests connection or removal to an AC BUS,
- S1: established synchronization signal, the APU GEN is within +/- 5VAC, +/- 0.5HZ, +/- 15 degrees phase difference from the reference AC source or the EXT PWR is 115VAC +/- 5VAC, 400HZ +/- 10HZ and available.

NOTE: Note: The reference AC source is established by the GAPCU according to the presently available AC sources.

- This function is called the FRU function inside the GAPCU. The FRU establishes a priority depending upon the available AC power sources and uses the FRU AC power source as the reference for synchronization, only on the ground. The FRU AC reference priority is determined by the AC power source configuration and may or may not be the same reference sent to the left side of the network or the right side of the network.
- FRU priority:
- EXT PWR A
- EXT PWR B
- APU GEN
- Master 400HZ reference.
- S2: indicating the end of the NBPT function,

From the GAPCU to GCU:

- FRU: indicating the FRU change signal, once the APU GEN is connected to the network,

From the GAPCU to Electronic Control Box (ECB):

- APU RAMP: signal (ARINC 429) to "ramp" the APU shaft speed up or down for phase alignment purposes.

From the ECB to GAPCU:

- APU READY: signal when the APU speed is greater than 95%.

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NOTE: Note: The APU READY signal is performed once APU speed is greater than 95 %.

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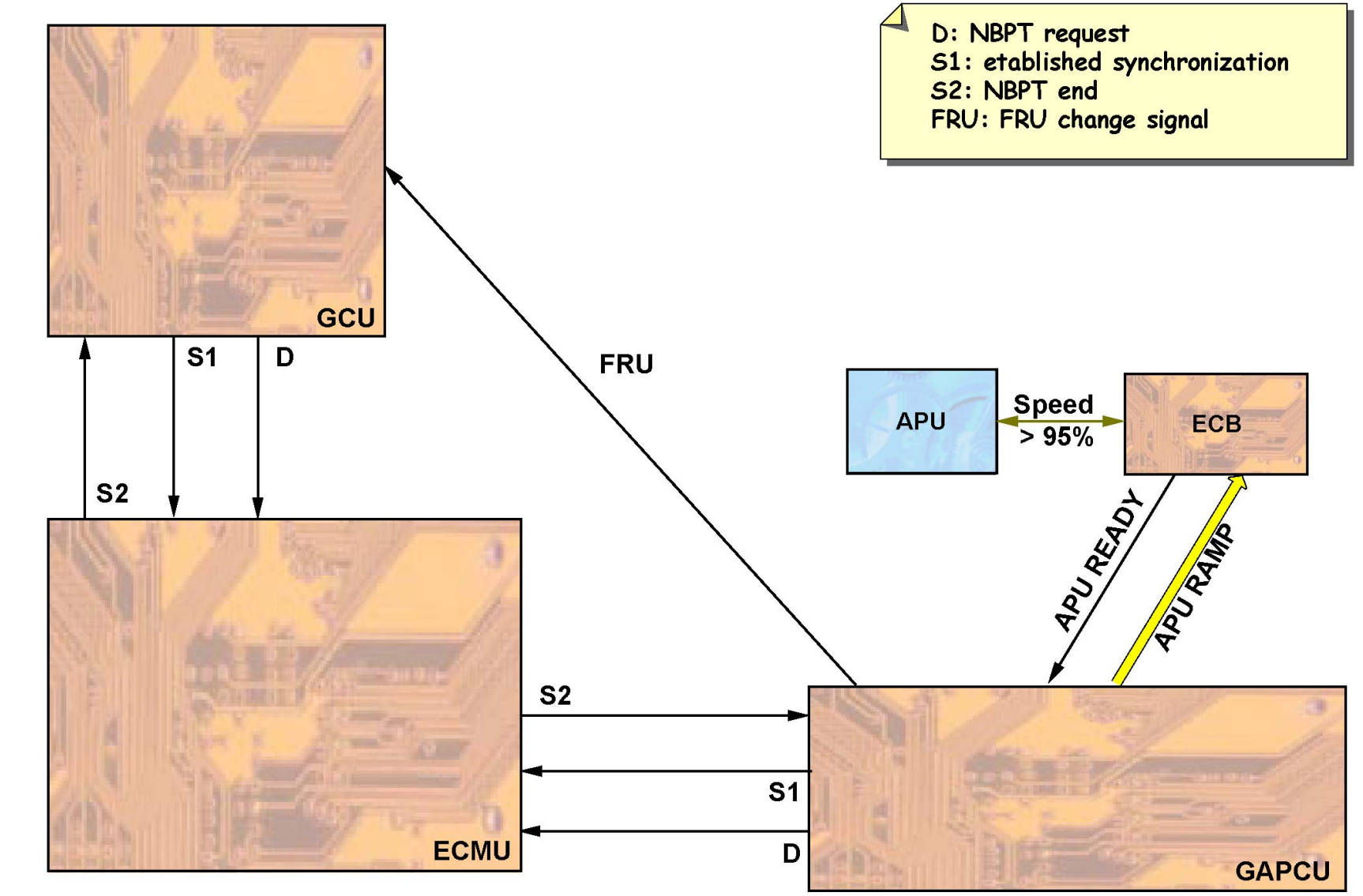

NBPT FUNCTION - NBPT LINK

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CONTACTORS MANAGEMENT D/O (3)

NBPT OPERATION

This topic presents different examples of NBPT functions.

A/C CONFIGURATION

The LH side of the electrical network is supplied by EXT PWR B alone. The RH side is supplied by EXT PWR A alone, SIC is open. EXT PWR A and B are controlled and monitored by the GAPCU.

NOTE: Note: A NBPT cannot be accomplished between EXT PWR A and EXT PWR B.

APU GEN / EXT PWR B NBPT STARTING

EXT PWR B is connected. The APU GEN is going to be connected to the LH AC busbars, a momentary paralleling is performed for a very short time between the present AC BUS supply source (EXT PWR B) and the source to be connected, APU GEN.

APU AT 95%

By pressing the APU START P/B, the APU start sequence begins. The "D" signal is sent to the GAPCU. At 95% rated speed, the ECB sends the APU READY signal to the GAPCU. The APU GEN Control part of the GAPCU controls and monitors the APU GEN parameters and when they are within accepted limits, it sends the "D" signal to both ECMUs.

APU GEN READY

The FRU sends the EXT PWR B frequency data to the APU GEN control, which is a part of the GAPCU. If the FRU is within the limits of 390 to 410 Hz, the APU GEN control part sends the "APU RAMP" signal to the ECB.
This "APU RAMP" signal is an ARINC 429 signal that will cause the ECB to adjust the APU shaft speed. The speed adjustment rate and direction depends on the difference between the frequency of EXT PWR B (FRU) and the APU GEN frequency. When the APU GEN frequency (+/- 0.5 Hz) and phase angle (+/- 15 degrees) match the FRU, the GAPCU issues the "S1" synchronization signal to both ECMUs. This indicates that the APU GEN is now ready to be momentarily placed in parallel with EXT PWR B.
A paralleling is performed between the effective busbar supply source (EXT PWR B to LH side busbars) and the new source to be connected (APU GEN). Upon APU GEN connection to aircraft network, the paralleling function is stopped. EXT PWR B is removed from the AC BUS.

APU TAKE-OVER FROM EXT PWR B

ECMU 1 closes the APU GLC, placing the APU GEN in parallel with the EXT PWR B on the transfer line, and then opens the EPC B. The APU GEN powers left side electrical network. The NBPT is now completed.

APU GEN FREQUENCY is now THE NEW FREQuency REFerence (FRU) FOR A NEW NBPT DEMAND (ON "D" SIGNAL REQUEST)

When EPC B opens, the EXT PWR B "S1" signal, the APU GEN ramp signal, and the APU GEN "S1" signal are all removed from the GAPCU. When the APU GEN ramp signal is removed, the APU ECB regulates the APU GEN frequency to 400 Hz through APU "N" speed adjustment. The FRU for the LH side of the aircraft changes from EXT PWR B frequency to the APU GEN frequency.

APU GEN / EXT PWR B NBPT SHUTDOWN

The APU GEN is going to be disconnected from the LH side electrical network; a paralleling is performed for a very short time between the effective supply source (APU GEN) and the source to be connected (EXT PWR B) in this case.

APU MASTER P/B TO OFF

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The APU GEN supplies the LH side. As long as the APU MASTER P/B is ON, the APU GEN remains valid for an NBPT function. When it is set to OFF the GAPCU receives a discrete "shutdown" signal. Prior to APU shutdown (or APU MASTER P/B to OFF) the GAPCU will:
- remove the "D" signal to the ECMUs indicating that the APU GEN is being shutdown and NBPT is requested,
- issue the frequency change request signal (S4) to the FRU (the FRU switches reference to EXT PWR B and provides this signal to the LH side GCU).

When the APU GEN control part receives the frequency reference signal (EXT PWR B) from the FRU, it generates the RAMP signal to the ECB. If the frequency reference signal is within the limits of 390 to 410 Hz, the ECB adjusts the APU speed. The speed adjustment rate and direction depends on the difference between the reference frequency (FRU) of EXT PWR B and APU GEN.
When the APU GEN frequency and phase angle are within limits of the frequency reference signal, the S1 signal is sent to the ECMUs indicating that the APU GEN is ready to be momentarily placed in parallel with the EXT PWR B source. Upon EXT PWR B connected to A/C network, the paralleling function is terminated; APU GEN is removed from the network.
After a short time delay, ECMU 1 opens the APU GLC and EXT PWR B supplies the LH side. If no other power sources (EXT PWR A or IDG) are connected to the RH side, ECMU 1 closes the SIC and EXT PWR B also supplies the RH side network.

NOTE: Note: If synchronization between APU GEN and EXT PWR cannot be achieved within 15 seconds, a conventional break power transfer is achieved.

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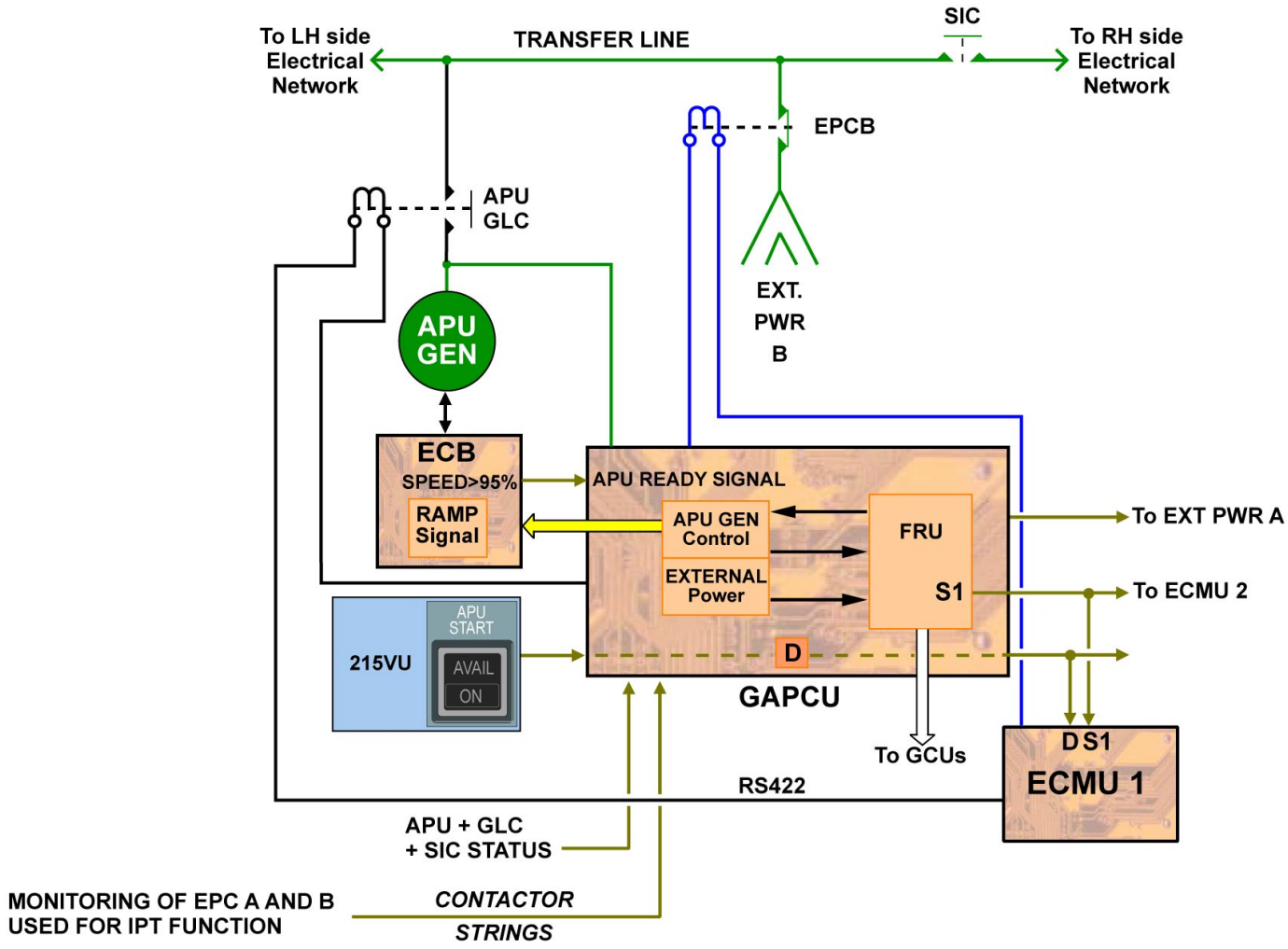

APU GEN / EXT PWR B NBPT STARTING and SHUTDOWN

NBPT OPERATION - A/C CONFIGURATION ... APU GEN / EXT PWR B NBPT SHUTDOWN

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CONTACTORS MANAGEMENT D/O (3)

NBPT OPERATION (continued)

GEN 1 / APU GEN NBPT STARTING

NOTE: Note: To illustrate this NBPT sequence between GEN 1 and APU GEN, A330 LH side electrical network is shown as example. The NBPT sequence between GEN 2 and APU GEN is the same for A340.

IDG 1 GEN. ON LINE CONNECTION

The APU GEN supplies the LH side. When ENG 1 is running and IDG 1 parameters are within the accepted limits, GCU 1 issues the "D" signal to the ECMU's upon closure of GCU Power Ready Relay (PRR).

IDG 1 GEN. OUTPUT IS IN PHASE WITH APU GEN. OUTPUT

The FRU sends the APU GEN frequency reference to GCU 1. When IDG 1 frequency and phase angle are within limits of the frequency reference (APU GEN), GCU 1 issues the "S1" signal to both ECMUs. The "S1" signal indicates that IDG 1 is ready to be momentarily placed in parallel with the APU GEN.

PHASE ALIGNMENT

IDG 1 SUPPLY LH SIDE ELECTRICAL NETWORK

ECMU 1 closes GLC 1 to place the IDG 1 in momentary parallel with the APU GEN on LH side electrical network. Then BTC 1 opens. IDG 1 powers the LH side electrical network and the APU GEN is disconnected from electrical network (for A340, APU GEN will be disconnected from AC BUS 1-1 and will be supply AC BUS 1-2). The NBPT is then completed.

BTC FAILURE

The A/C is powered by the APU GEN for the LH side busbar(s) and EXT PWR A for the RH side busbar(s) (SIC is open).

When ENGINE MASTER SW (fuel lever) 1 is set to ON, a NBPT occurs between the APU GEN and IDG 1. Normally, 80 ms after closing of GLC 1, ECMU opens BTC 1.
If BTC 1 stays closed after 130 ms, ECMU 1 opens the APU GLC. If it remains closed, after 160 ms, GCU 1 takes over and ensures BTC 1 opening by using the BTC lock-out function in the GCU. If the BTC 1 still remains closed, after 220 ms, the GCU will trip the generator control relay (GCR) and the PRR inside the GCU that will open the GEN 1 GLC and remove GEN 1 from the AC BUS. This is the back-up Inadvertent Paralleling Trip function inside the GCUs to protect against contactor failure and ECMUs failure of managing the AC contactors. The GCUs and the GAPCU monitor the respective AC contactors (Contactor Strings - CTR STG) to accomplish this ultimate Inadvertent Paralleling Trip protection.

NOTE: Note:
- BTC lock-out function is automatically reset by the GCU,
- the back-up Inadvertent Paralleling Trip function is only reset two times by cycling the corresponding GCU P/BSW,
- cold start resets automatically all Inadvertent Paralleling Trip protective functions.

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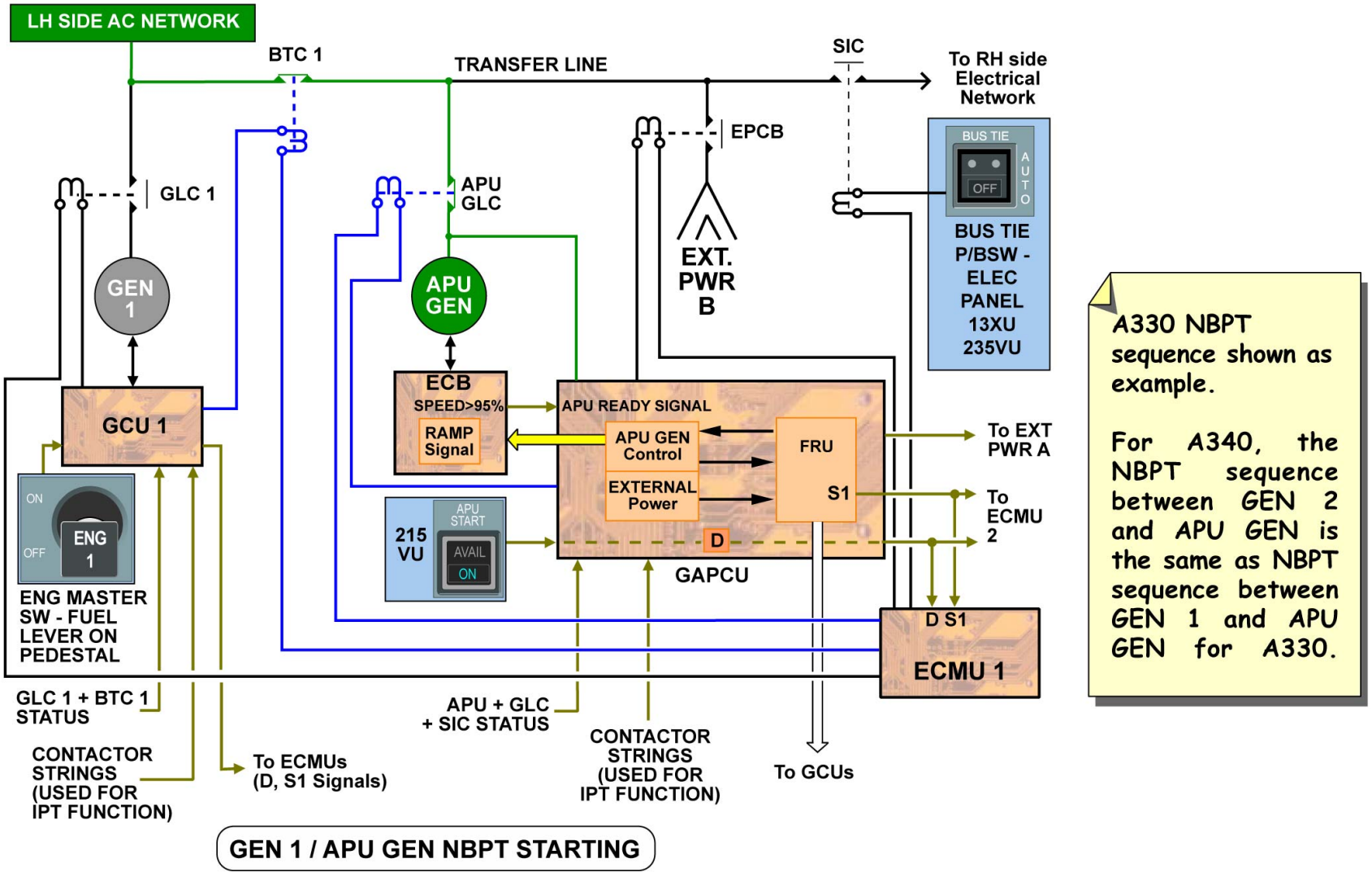

NBPT OPERATION - GEN 1 / APU GEN NBPT STARTING ... BTC FAILURE

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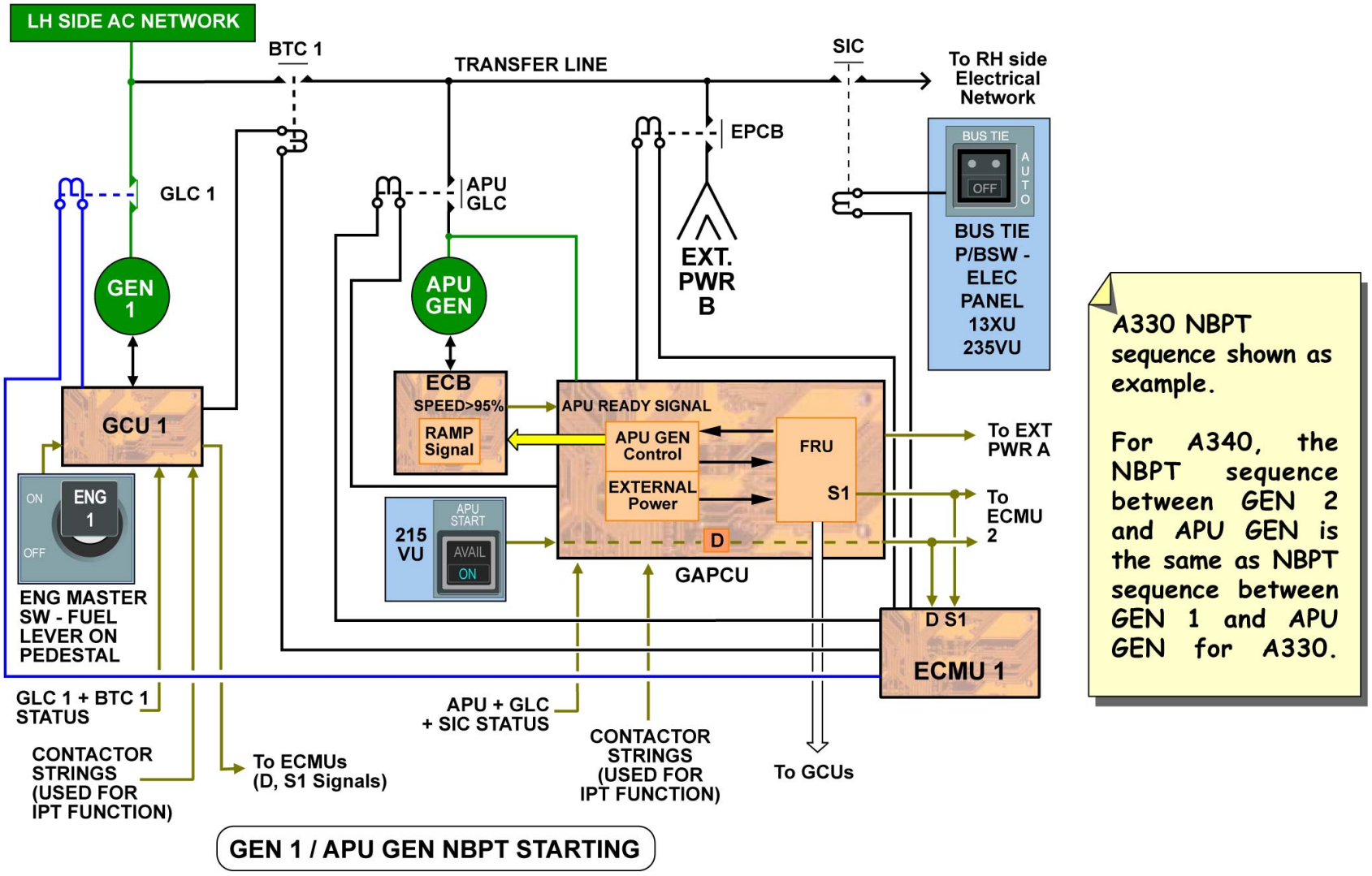

NBPT OPERATION - GEN 1 / APU GEN NBPT STARTING ... BTC FAILURE

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CONTACTORS MANAGEMENT D/O (3)

ABNORMAL OPERATION

ECMU CLASS 2 FAILURE

If a CLASS 2 failure is detected by the ECMUs, a MAINTENANCE STATUS message (ECMU 1 or ECMU 2) is transmitted to the SDACs. The failure message will be displayed on the ECAM SYSTEM DISPLAY (SD), under MAINTENANCE, in white, in the lower right of the ECAM STATUS PAGE. Trouble Shooting Manual (TSM) entry is required using the MAINTENANCE STATUS message.

TOTAL FAILURE OF ONE ECMU

In the case of total loss of an ECMU, a CLASS 1, level 2 ECAM message (amber MASTER CAUTION - SINGLE CHIME and amber ECAM message: ECMU FAULT (on E/WD), with automatic display of AC/EL PAGE on ECAM SD).
Due to the loss of the ECMU, the control of the on-side contactors is lost:
- in the case of loss of ECMU 1, the following contactors are no longer controlled: GLC 1 and 2 (GLC 1 only for A330), BTC 1 and 2 (BTC 1 only for A330), AGLC, EPC-B and SIC,
- in the case of loss of ECMU 2, the following contactors are no longer controlled: GLC 3 and 4 (GLC 2 only for A330), BTC 3 and 4 (BTC 2 only for A330), EPC-A.

The transfer circuit reconfiguration becomes inoperative. Should a ECMU fail, a specific crew procedure message on the E/WD informs the crew to keep the GEN on line. This procedure is the result of the self-holding closed function of the IDG GLC by the GCU. Once the ECMU and the GCU close an IDG GLC, the GCU keeps the IDG GLC closed through a self-holding discrete. If the ENG GEN P/BSW is selected OFF, the failed ECMU will not be able to assist the GCU in re-closing the IDG GLC.

NBPT INHIBITION

The NBPT function is inhibited if the system detects that an electrical transfer with non-synchronized power sources may occur. This behavior is aimed at protecting the electrical network. It can originate from an incorrect status of the contactor string, or by one of the following actions:
- action on the "BUS TIE" cockpit P/B,
- APU auto-shutdown,
- Manual shutdown by means of one of the manual emergency shutdown switches:
- APU SHUT OFF at the nose landing gear,
- APU EMERGency SHUT DOWN on the refuel/defuel panel at the belly fairing.
- APU FIRE PUSH on overhead panel,

If one of the above actions is performed, the GAPCU generates a BITE message and inhibits any subsequent NBPT operation. Refer to the specific TSM task for the specific BITE message.

GAPCU RESET AFTER NBPT INHIBITION

To reset a NBPT function failure, entry into the TSM using the specific ECAM message(s) and/or BITE message(s) is necessary for a proper corrective procedure.

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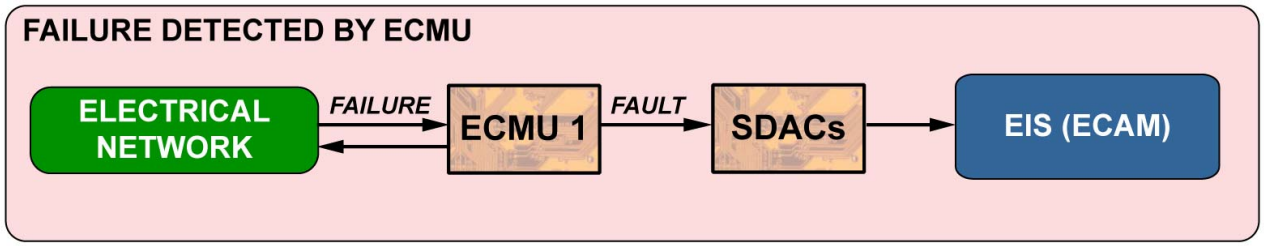

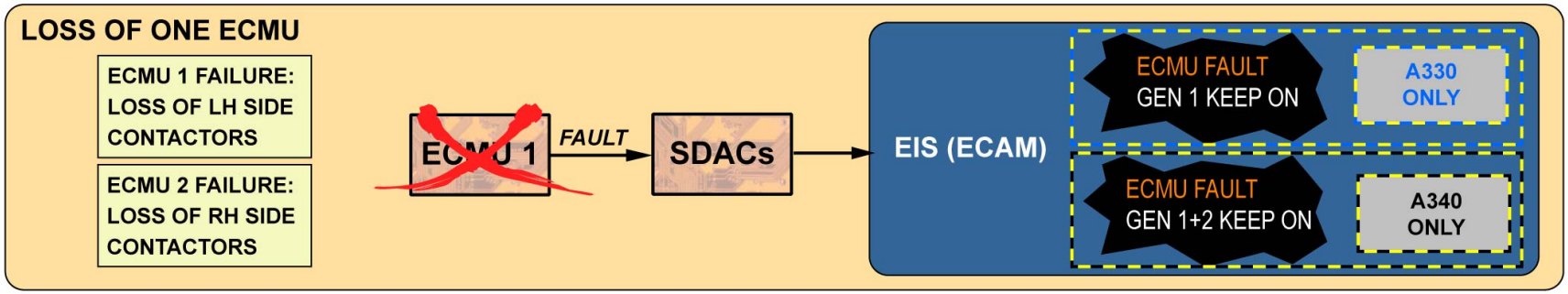

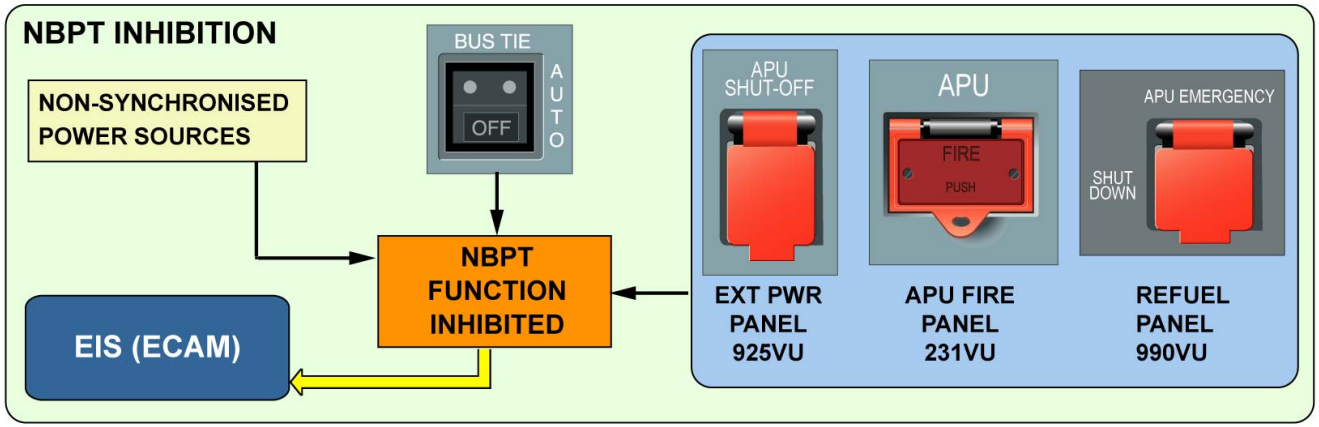

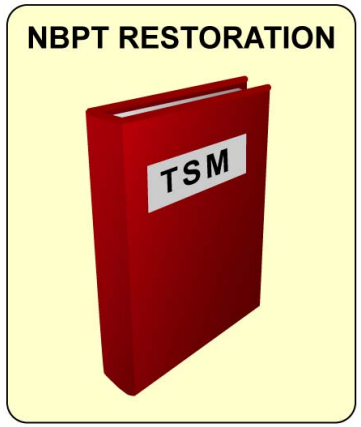

ABNORMAL OPERATION - ECMU CLASS 2 FAILURE ... GAPCU RESET AFTER NBPT INHIBITION

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MAIN DC GENERATION D/O (3)

GENERAL

The DC main and ESSential generation consists of four identical and interchangeable Transformer Rectifiers (TRs) and their related contactors.
TR1, supplied by AC BUS 1, and TR2, supplied by AC BUS 2, compose the DC main generation. These TRs respectively supply DC BUS 1 and DC BUS 2.
The APU TR, supplied by AC BUS 2, is used to charge the APU BATtery and to start the APU.
DC ESS network is supplied by ESS TR, which is supplied by:
- AC BUS 1 in normal condition,
- AC BUS 2 in abnormal condition,
- EMERgency GENerator in emergency condition.

Each TR contains:
- a transformer part,
- a rectifier part,
- a monitoring card.

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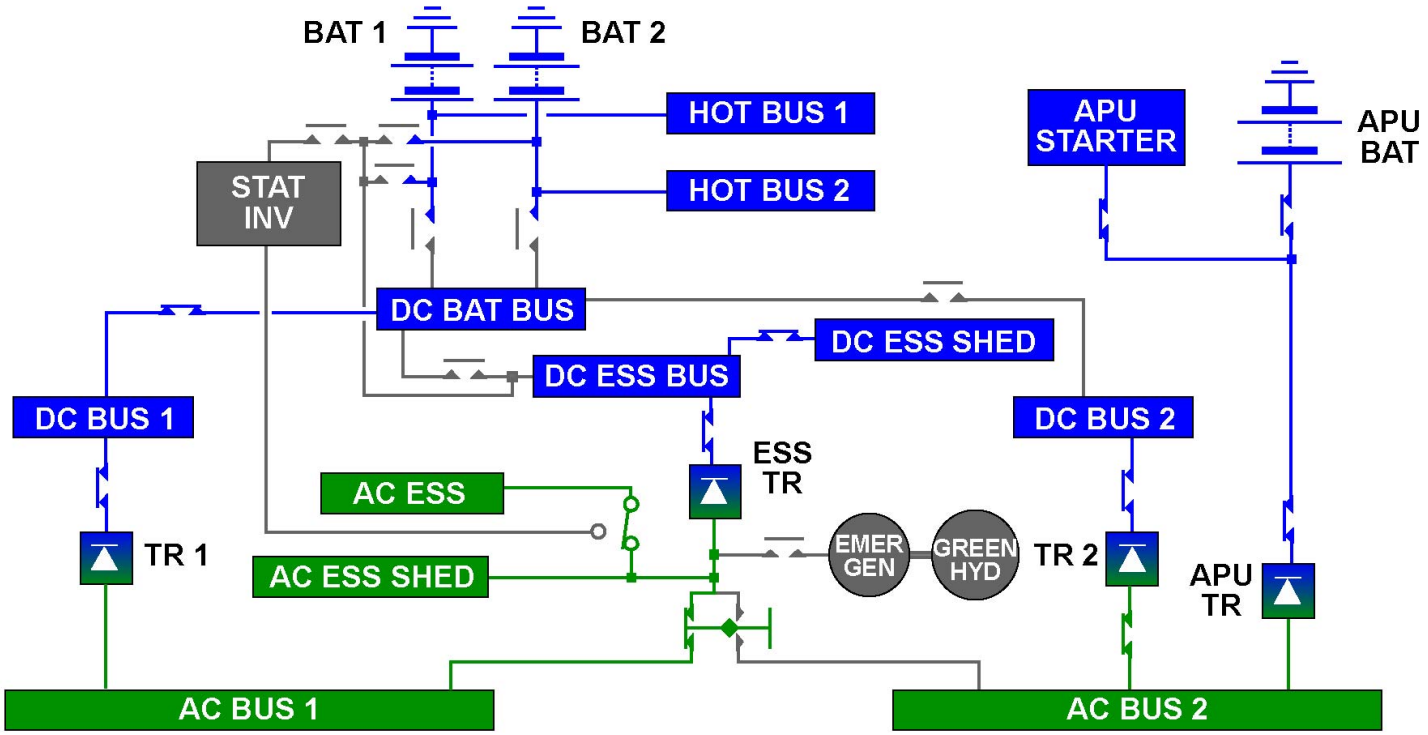
BAT 1
BAT 2
HOT BUS 1
HOT BUS 2
STAT INV
APU STARTER
APU BAT
DC BAT BUS
DC ESS SHED
DC ESS BUS
DC BUS 1
DC BUS 2
ESS TR
AC ESS
TR 1
EMER GEN
GREEN HYD
TR 2
APU TR
AC ESS SHED
AC BUS 1
AC BUS 2

GENERAL

MAIN DC GENERATION D/O (3)

MAIN TRANSFORMER RECTIFIERS 1 AND 2 (TR 1 AND TR 2)

This topic presents TR1 and TR2 description and operation.

TRANSFORMER RECTIFIER 1

TR1 converts the 115 VAC power from AC BUS 1 into 28 VDC. The monitoring card is supplied by the internal 28 VDC and from the bus 401PP as a back-up supply. The 28 VDC output is connected to DC BUS 1 via contactor 5PU1.

TRANSFORMER RECTIFIER 2

TR2 converts the 115 VAC power into 28 VDC from AC BUS 2 via the contactor 2PU, or on ground, with only EXTernal PoWeR A connected and the MAINTenance bus switch in ON position via contactor 6XX.
The monitoring card is supplied by the internal 28 VDC and from bus 101P as a back-up supply. If TR1 is not operating (5PU1 open), the monitoring card of TR2 is supplied from bus 403PP.
The 28 VDC output is connected to the DC BUS 2 and to the DC SERVICE BUS respectively via contactor 5PU2 and 1PN. The 28 VDC output can also be connected to the DC SERVICE BUS via contactor 1PX, only on ground with EXT PWR A connected and the MAINT bus switch in ON position.

INTERFACES

Both main TR1 and TR2 interface with following systems:
- System Data Acquisition Concentrators (SDACs) for ECAM warning and indications,
- Electrical Contactor Management Units (ECMUs) for control of contactors 1PC1 (CNTOR - 28VDC BUS 1 / DC BAT BUS SPLY) and 1PC2 (CNTOR - 28VDC BUS 2 / DC BAT BUS SPLY) for automatic transfer and short circuit protection,
- Centralized Maintenance Computer (CMC) for TR reset.

OPERATION

Each TR is operative if the AC corresponding busbar is supplied. If all parameters are correct, the TR contactors (5PU1 or 5PU2) closes and connects the power to the corresponding DC busbar.
In normal operation:
- TR1 and TR2 are supplied and active,
- 1PC1 is closed and 1PC2 is open.

If TR1 fails (not due to over-current):
- TR2 is still supplied by AC BUS 2,
- 1PC1 stays closed and 1PC2 closes.

If TR1 and TR2 fail (not due to over-current):
- 1PC1 and 1PC2 are open and DC BUS 1 and DC BUS 2 are not supplied. The DC BAT BUS will be momentarily supplied for approximately 7 seconds. After 7 seconds the DC BAT BUS will not be supplied.

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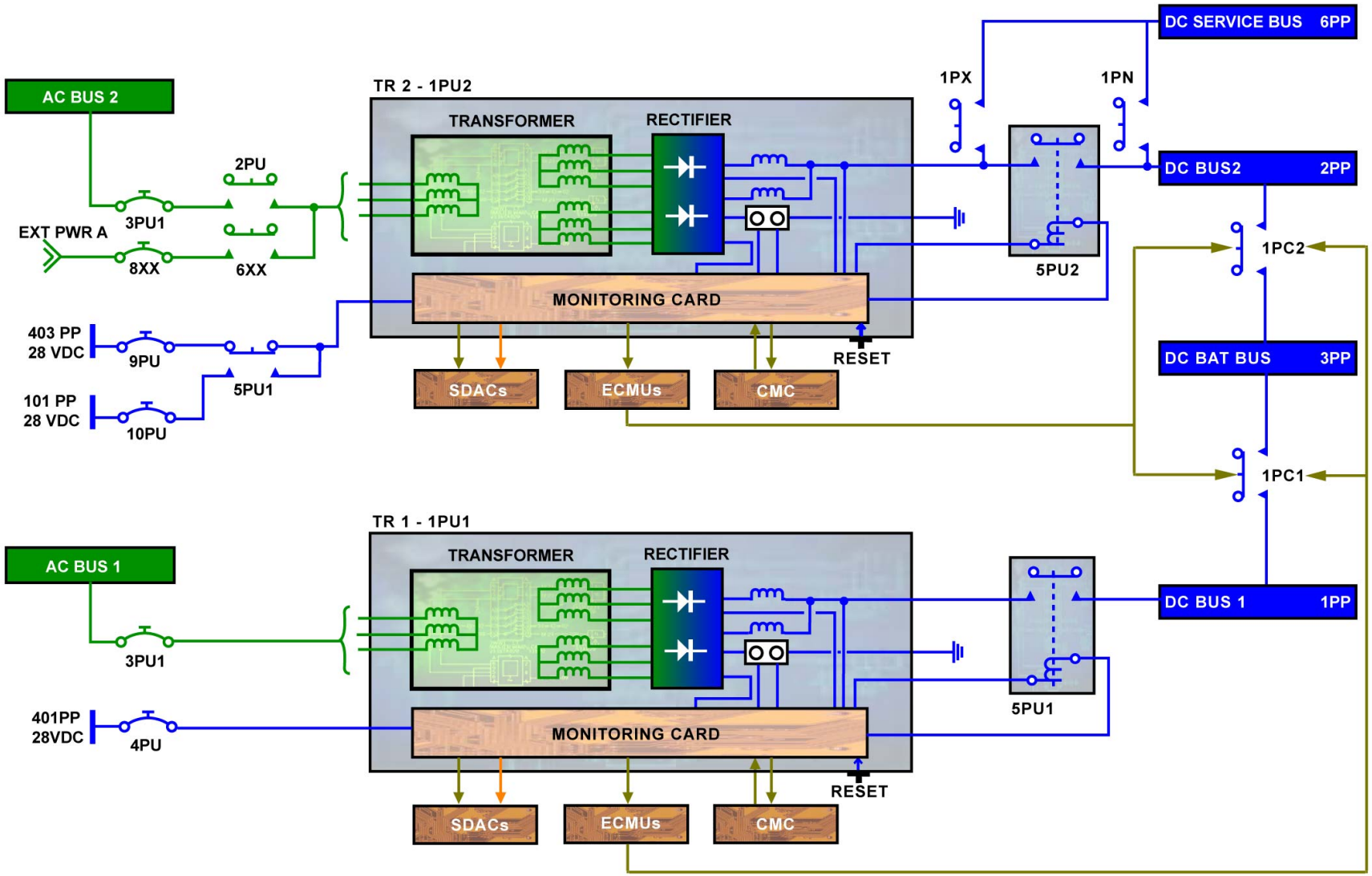

MAIN TRANSFORMER RECTIFIERS 1 AND 2 (TR 1 AND TR 2) - TRANSFORMER RECTIFIER 1 ... OPERATION

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MAIN DC GENERATION D/O (3)

APU TRANSFORMER RECTIFIER (APU TR)

This topic presents the APU TR description and operation.

DESCRIPTION

The APU TR converts the 115 VAC power from AC BUS 2 into 28 VDC.
The monitoring card is only supplied by an internal 28 VDC.
The 28 VDC output is connected:
- directly to busbar 909PP,
- via contactor 7PU: to busbar 309PP and APU starter,
- via contactor 5PB: to the APU BAT for charging and busbar 709PP.

NOTE: the APU starter is able to supply 3 successive APU starts every hour with an interval of 1 minute between 2 successive starts.

INTERFACES

APU TR interfaces with:
- SDACs for ECAM warning and indications,
- CMC for TR reset.

OPERATION

On the APU TR, if AC BUS 2 is supplied, the closed contactors 7PU connect the DC power to the contactors 5KA and 10KA, and also 5PB to respectively allow the APU starter and the APU BAT to be supplied.
The contactors 5KA is closed when the APU START P/BSW is pressed.

NOTE: The backup contactor 10KA is closed 1.5 sec before the contactor 5KA.

Otherwise 5PB is closed if the APU BAT needs charging.

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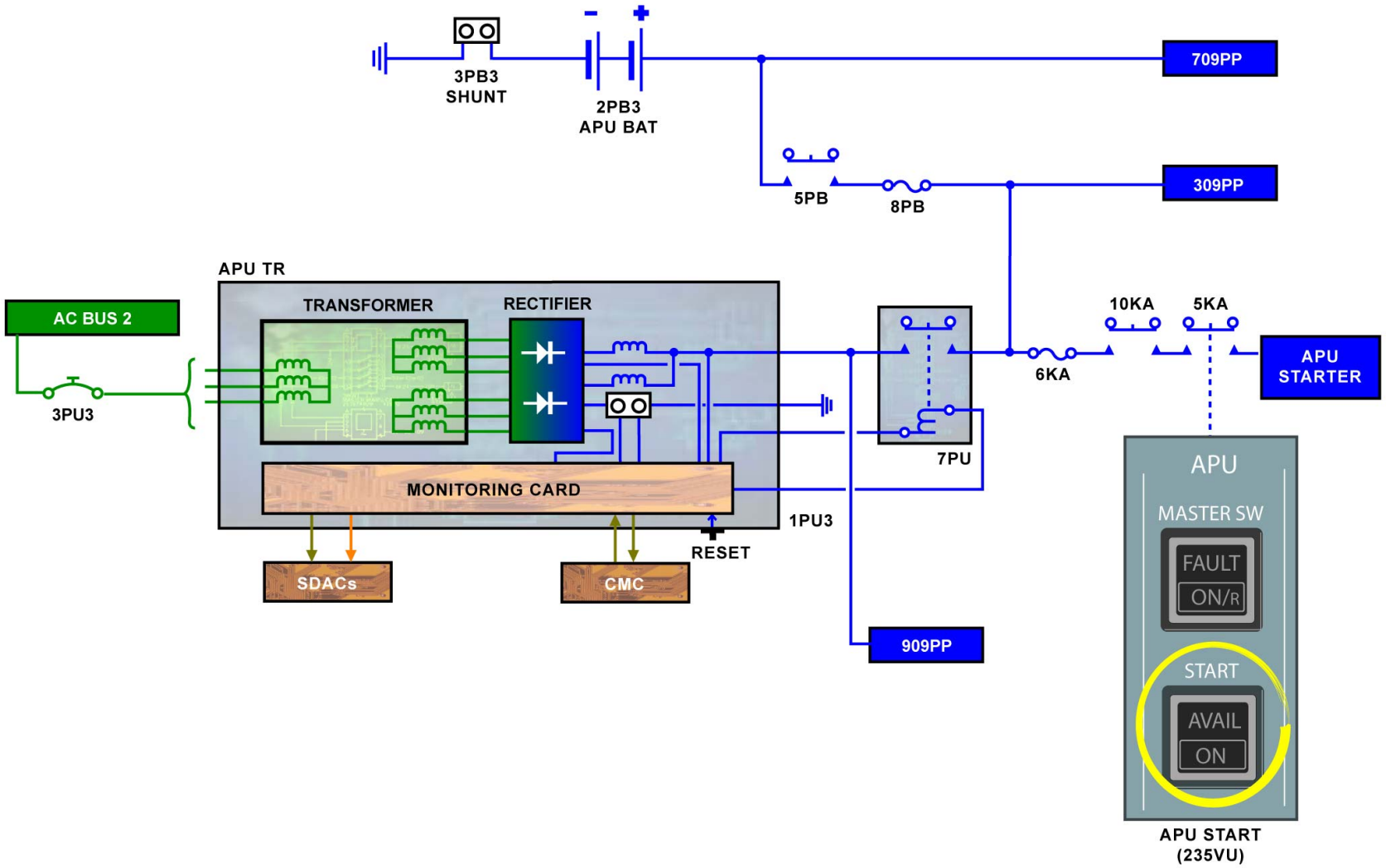

APU TRANSFORMER RECTIFIER (APU TR) - DESCRIPTION ... OPERATION

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MAIN DC GENERATION D/O (3)

ESSENTIAL TRANSFORMER RECTIFIER (ESS TR)

This topic presents the description and operation of the ESS TR and the description of the monitoring card of each TR.

DESCRIPTION

The ESS TR can be supplied with 115 VAC / 400 Hz 3 phases from:
- AC BUS 1 in normal configuration,
- AC BUS 2 automatically in case of loss of AC BUS 1 (abnormal configuration),
- EMER GEN automatically in case of loss of AC BUS 1 and 2 (emergency configuration).

The 28 VDC output is connected to the DC ESS BUS via the contactor 3 PE.
The monitoring card is supplied by the internal 28VDC and, as a back up supply, from DC BUS 101PP.

MONITORING CARD (COMMON FOR ALL 4 TRS)

The ESS TR monitoring card is taken as an example, the protection principle is the same for all 4 TRs.
The monitoring card contains the power supply module and the control and protection circuits.
Each TR is protected against:
- over-current,
- overheat (Transformer and Rectifier),
- open or short circuited diode (Rectifier).

Whenever a protection circuit is triggered, the DC output contactor (3PE for ESS TR) opens and remains open until a reset is performed.
A reset can be performed :
- from the MCDU via the CMC,
- from the reset button on the TR housing.

INTERFACES

The ESS TR interfaces with:
- SDACs for ECAM warnings and indications,
- CMC for TR reset.

OPERATION

The ESS TR is operative when it is supplied by AC BUS 1, or AC BUS 2 or EMER GEN. If all parameters are correct, the DC contactor 3PE closes and connects the power to the DC ESS network.
The DC ESS SHED BUS is lost in case of:
- loss of both AC BUS 1, AC BUS 2 and if CSM/G is supplied by the Ram Air Turbine (RAT),
- A/C electrical network on battery only (emergency configuration).

To avoid contactor 3PE opening during AC power transfer, the contactor 6PE opens if busbar 101PP is no longer supplied; this connects a ground to 3PE to keep it energized.
In case of ESS TR failure (not due to over-current), and if TR1 and TR2 are available, the contactor 4PC closes to allow the DC ESS BUS to be supplied from DC BUS 1 or DC BUS 2 via DC BAT BUS.

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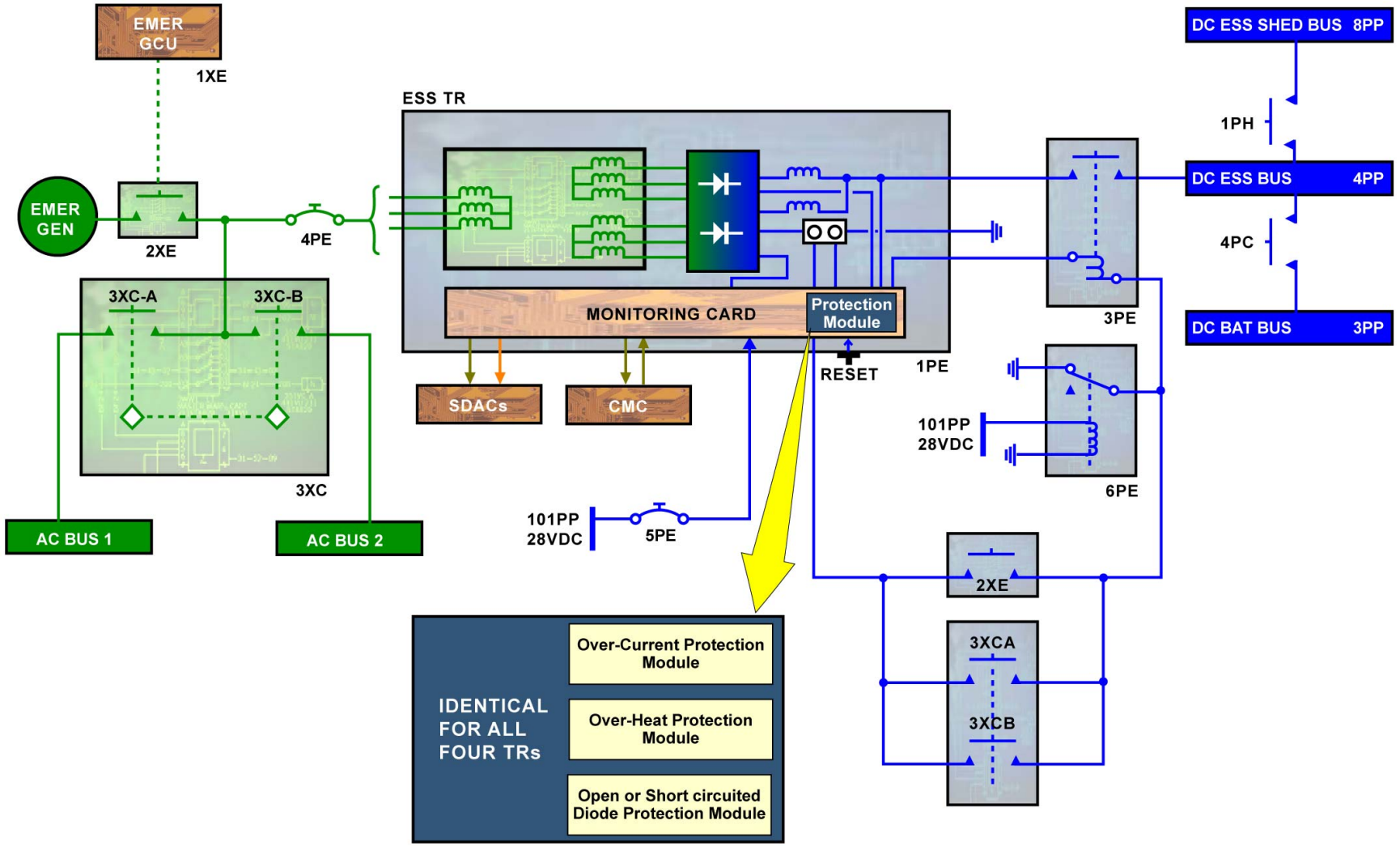

ESSENTIAL TRANSFORMER RECTIFIER (ESS TR) - DESCRIPTION ... OPERATION

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EMERGENCY DC GENERATION D/O (3)

BATTERIES

There are three batteries on board. The two main batteries, installed in the avionic bay, are used as a backup supply, when no other power source is available. The third battery, located in the APU compartment, is independent of the others and is mainly used for the APU starting.
The three BATteries are identical and interchangeable. Each BAT is ventilated by two ducts. The differential pressure between the cabin and the outside is used to provide battery ventilation.
Each BAT has 20 nickel cadmium accumulators in a titanium case, except for A340-500 and A340-600 in a stainless steel case. The BAT nominal voltage is 24VDC and the nominal capacity is 40 Ah, except for A340-500 and A340-600 with a nominal capacity of 50 Ah.
Each battery is associated to one Battery Charge Limiter (BCL) which ensures the BAT charge/discharge and protection by controlling the BAT contactor.

APU BATTERY

The APU BAT is mainly used for the APU start. The APU BCL ensures BAT charge/discharge and protection in the same way as for the main BATs.

MAIN BATTERIES

The two main BATs are used to supply the STATic INVerter and the DC ESS BUS via the contactors 2PC and 3PC.
HOT BUSES are directly connected to BATs and are always supplied.

BATTERY CONTROL, INDICATING AND MONITORING

Each BCL is controlled by means of a P/BSW located on the overhead ELEC panel (235VU).

In OFF position the P/BSW is released out. The BCL is de-energized and the BAT cannot be connected to the BAT BUS. The OFF legend comes on white. The message 'BAT OFF' is displayed on the ECAM.
In ON position the P/BSW is pressed in. The BCL is energized and automatically monitors and controls the coupling or uncoupling of the BAT.
If a BAT thermal runaway or short circuit is detected, the BAT contactor automatically opens and the FAULT amber legend illuminates in the BAT P/BSW with the ECAM warning [BAT (1)(2)(APU) FAULT]. In this case, the P/BSW must be released out (OFF position).
The battery parameters are displayed on the ECAM EL/DC page and on the voltmeter which is located on the overhead ELEC power panel.
System failures and BITE data are sent to the Centralized Maintenance Computer (CMC).

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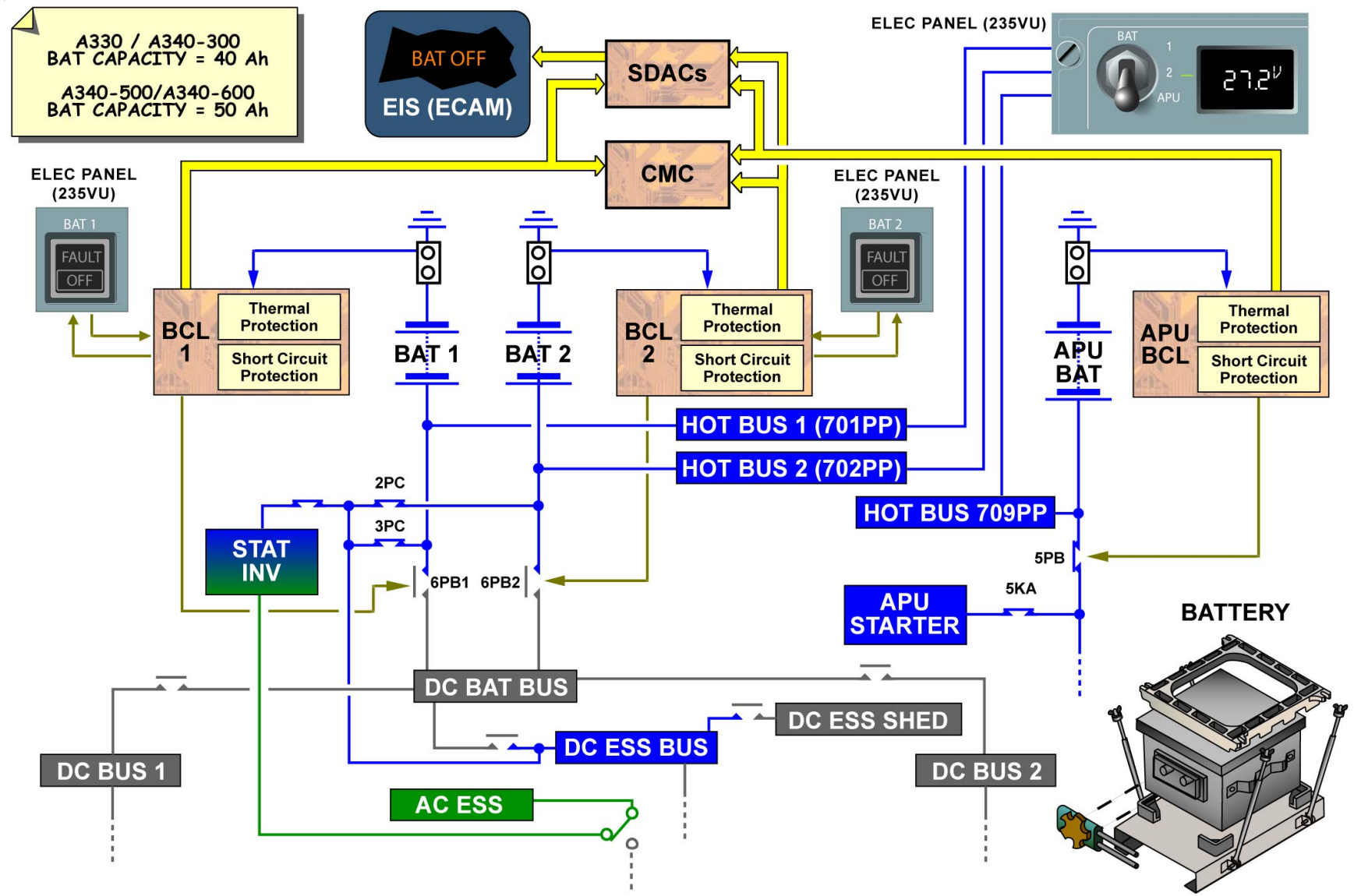

BATTERIES - APU BATTERY ... BATTERY CONTROL, INDICATING AND MONITORING

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EMERGENCY DC GENERATION D/O (3)

BATTERY CHARGE LIMITER (BCL)

BCL 1 is taken for example. The principle is the same for BCL 2.
The three BCLs are identical and interchangeable. A PIN programming determines the position of the BCL (1, 2 or APU) and the A/C type.
The main functions of the BCLs are to control, monitor and protect the corresponding BATtery, control the BAT contactor and the BAT FAULT warning. BCL 1 and BCL 2 also control the EMER GEN FAULT warning.
The BCL BAT contactor control functions are:
- ensuring BAT charging,
- protect the BAT against thermal runaway or short circuit,
- prevent complete BAT discharge on the ground
- maintain HOT BUS supply in case of short circuit on the BAT BUS.

Note that BCL 1,2 also ensure power supply of DC BAT BUS when no electrical power is available.
Each BCL is supplied by its own battery via sub-busbar 301PP, provided the corresponding battery P/BSW is pressed in.

BATTERY CHARGE

When BAT voltage is lower than 26.5 V and DC BAT BUS higher than 27 V, the BAT contactor 6PB1 is closed for battery charging.
When the charge current is less than 4 A decreasing for 10 seconds on ground, or 15 minutes in flight, the BAT contactor 6PB1 opens.
When the BAT voltage reaches 26.5 V, another charge cycle starts.

PROTECTIONS

If the charge current is above 10 A and increasing, the thermal runaway protection opens the BAT contactor and the warnings are triggered.
If the charge current is greater than 150 A for 90 seconds, there is a battery short circuit, so the BAT contactor opens and the warnings are triggered.

After these 2 types of failure configurations, the corresponding BAT P/BSW must be set to OFF. Setting the P/BSW to ON again resets the BCL.
To prevent the A/C against a complete BAT discharge, on ground, when the BAT voltage is lower than 23 V for 60 seconds, the BAT contactor 6PB1 opens automatically.
In order to maintain the HOT BUS supply, the BAT contactor 6PB1 opens under these conditions:
- discharge current greater than 100 A for 0.3 seconds (software protection for DC BAT BUS short circuit),
- discharge current is greater than 400 A and BAT voltage less than 13 V for 5 ms (hardware protection).

On ground with speed less than 50 Kts, when all AC BUSES are not supplied, BCL 1 and 2 close contactors 6PB1 and 6PB2 to supply DC BAT BUS 3PP.

FAULT LIGHTS

In EMER configuration, if the Constant Speed Motor/Generator (CSM/G) is inoperative, the EMER GEN FAULT light comes on red on the EMER ELEC POWER panel. This light is controlled by BCL 1 and 2.
Note that EMER GEN shutdown signal is sent to the BCL to illuminate the red FAULT light.
In case of thermal runaway or short circuit, the FAULT legend of the BAT P/BSW comes on amber.

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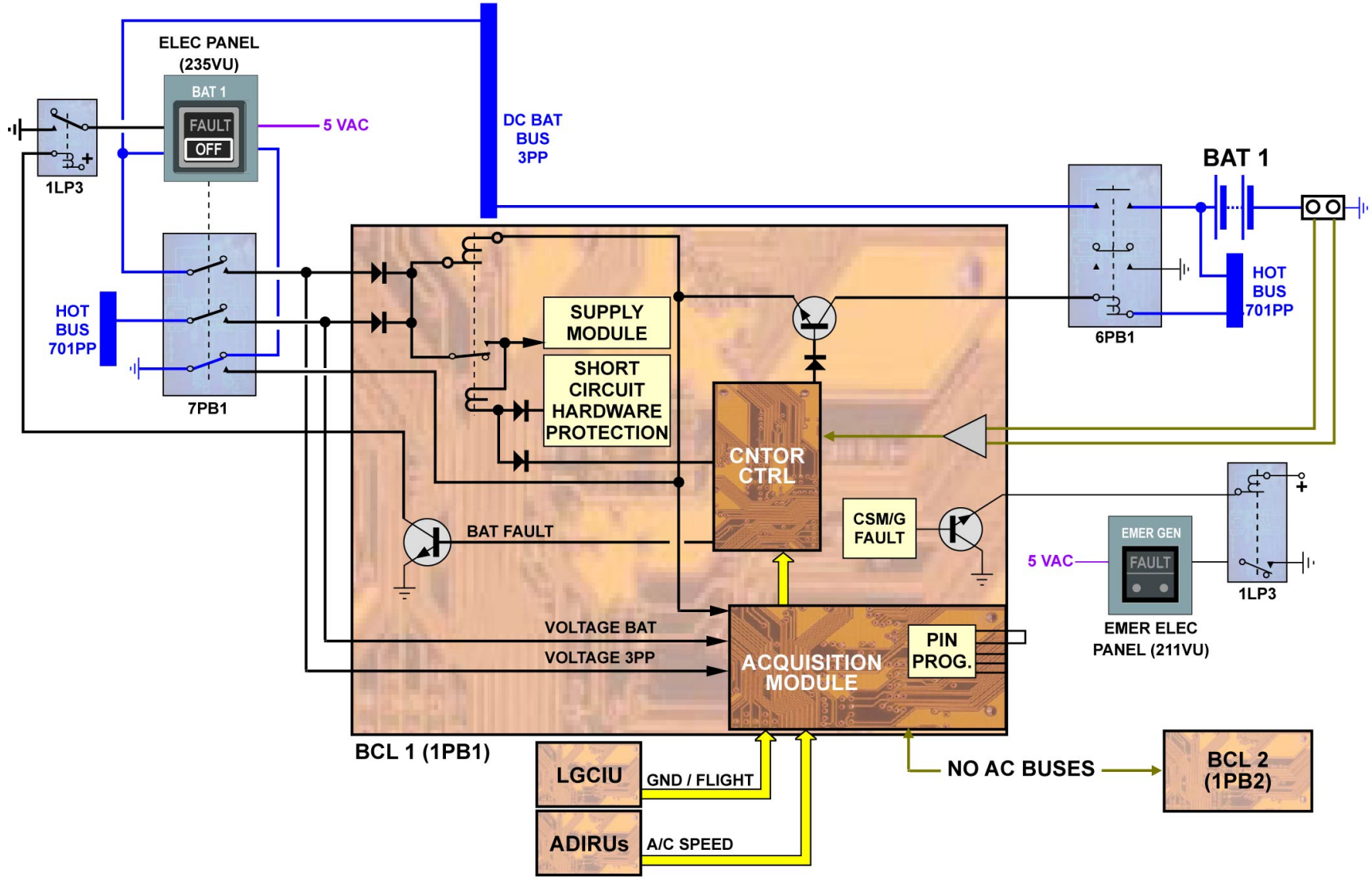

BATTERY CHARGE LIMITER (BCL) - BATTERY CHARGE ... FAULT LIGHTS

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EMERGENCY DC GENERATION D/O (3)

BATTERY CHARGE LIMITER (BCL) (continued)

APU STARTING

This topic explains the APU BCL functions and operation.
The charge and discharge cycles are similar with BCL 1 and BCL 2.
The main functions of APU BCL are to control the APU BAT contactor for the control, monitoring and protection of the APU BAT.
When the APU starting sequence is initiated, the APU BCL closes the APU BAT contactor 5PB. This provides power to start the APU.
As soon as the APU MASTER P/BSW is set to on, the APU Electronic Control Box (ECB) provides a signal to the APU BCL to close contactor 5PB.
If the APU Transformer Rectifier (TR) is operating, its output is connected to 309PP. If the APU TR is not operating, contactor 7PU sends a ground signal to the APU BCL to increase the current limitation. This allows APU STARTING on battery alone.
To prevent complete discharge of APU BAT during APU start, APU BCL opens contactor 5PB in the following cases:
- if APU BAT voltage is lower than 9.5 V during 1.5 seconds,
- or if APU BAT voltage is lower than 12 V during 15 seconds.

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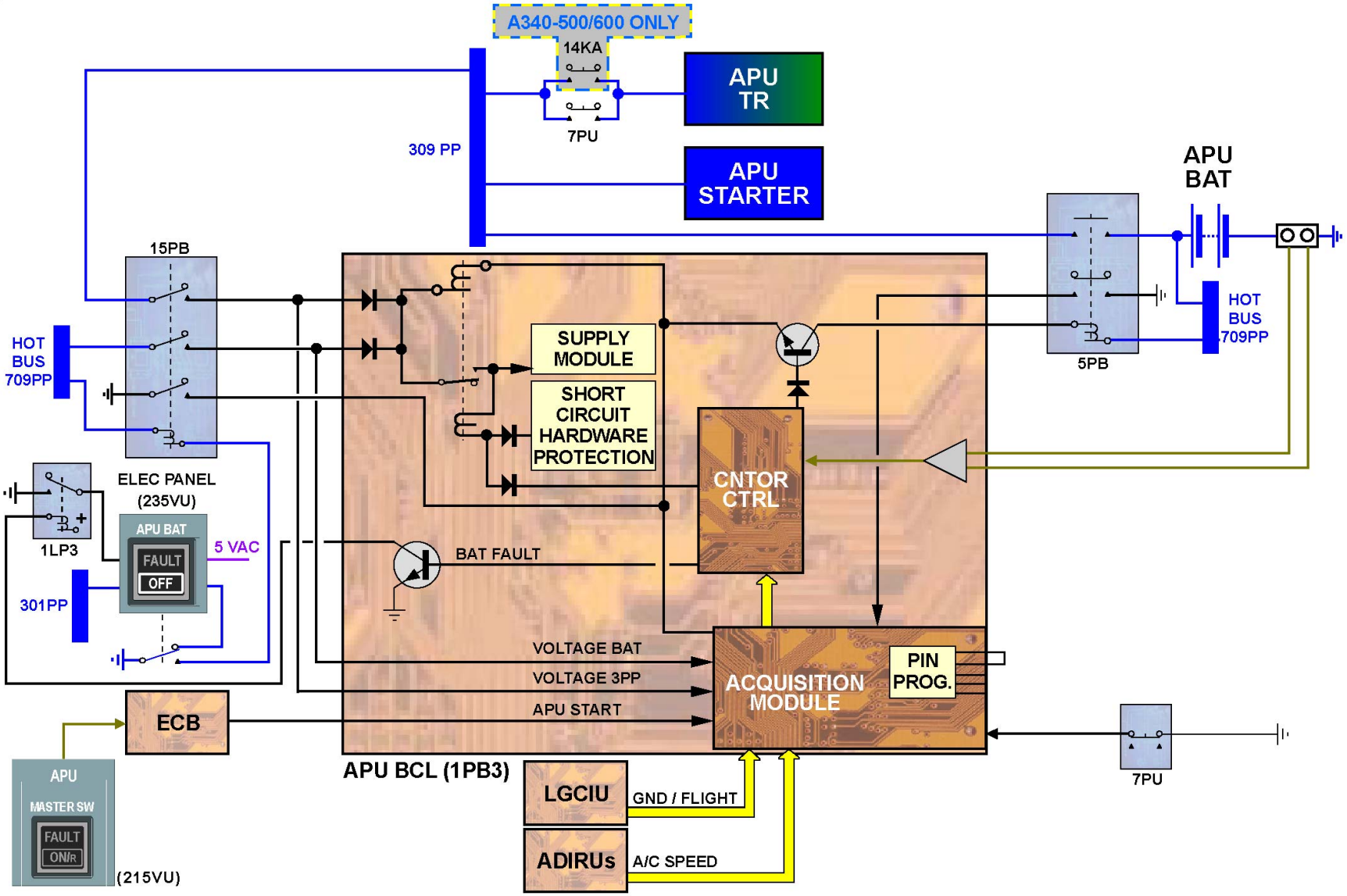

BATTERY CHARGE LIMITER (BCL) - APU STARTING

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EMERGENCY DC GENERATION D/O (3)

DC NORMAL GENERATION SWITCHING

This circuit monitors and controls the DC normal network supply (DC BUS 1, DC BUS 2 and DC BAT BUS).
The switching enables:
- normal supply of the DC busbars,
- automatic power transfer in case of failure and,
- transfer inhibition in case of a short circuit.

DC NORMAL BUS SWITCHING

The switching circuit consists of contactors 1PC1 and 1PC2. They are controlled in parallel by the Electronic Contactor Management Units 1 and 2 (ECMU 1 and 2).

ECMU

The DC supply configuration is sensed by the ECMUs. Due to supply changes, the ECMUs provide control logic for contactors 1PC1 and 1PC2.
In normal supply configuration, contactor 1PC1 is closed and 1PC2 is opened.

NORMAL OPERATION

In normal configuration the LH side AC BUS is supplied and TR1 is operating (contactor 5PU1 closed), ECMU1 internal control logic closes contactor 1PC1. 1PC1 contactor control logics only active in ECMU 1 and ECMU 2 internal control logic keeps contactor 1PC2 open.

ABNORMAL OPERATION

If TR1 fails, not due to over-current, ECMU1 detects that 5PU1 is open, and then opens 1PC1.
ECMU2 detects that 1PC1 is open and closes 1PC2 to supply DC BAT BUS.
As soon as 1PC2 is closed, ECMU2 closes 1PC1 to supply DC BUS 1 from DC BAT BUS.
TR2 now supplies the three DC buses (DC BUS 2, DC BAT BUS and DC BUS1).
If TR1 fails due to over-current, contactor 5PU1 opens. ECMU1 opens 1PC1.
The TR1 overcurrent signal inhibits the closure of 1PC2 and 1PC1.
If TR1 and TR2 are faulty, contactors 1PC1 and 2, and 5PU1 and 2 stay open.
Power is no longer supplied on DC BUS 1, DC BUS 2 and DC BAT BUS.

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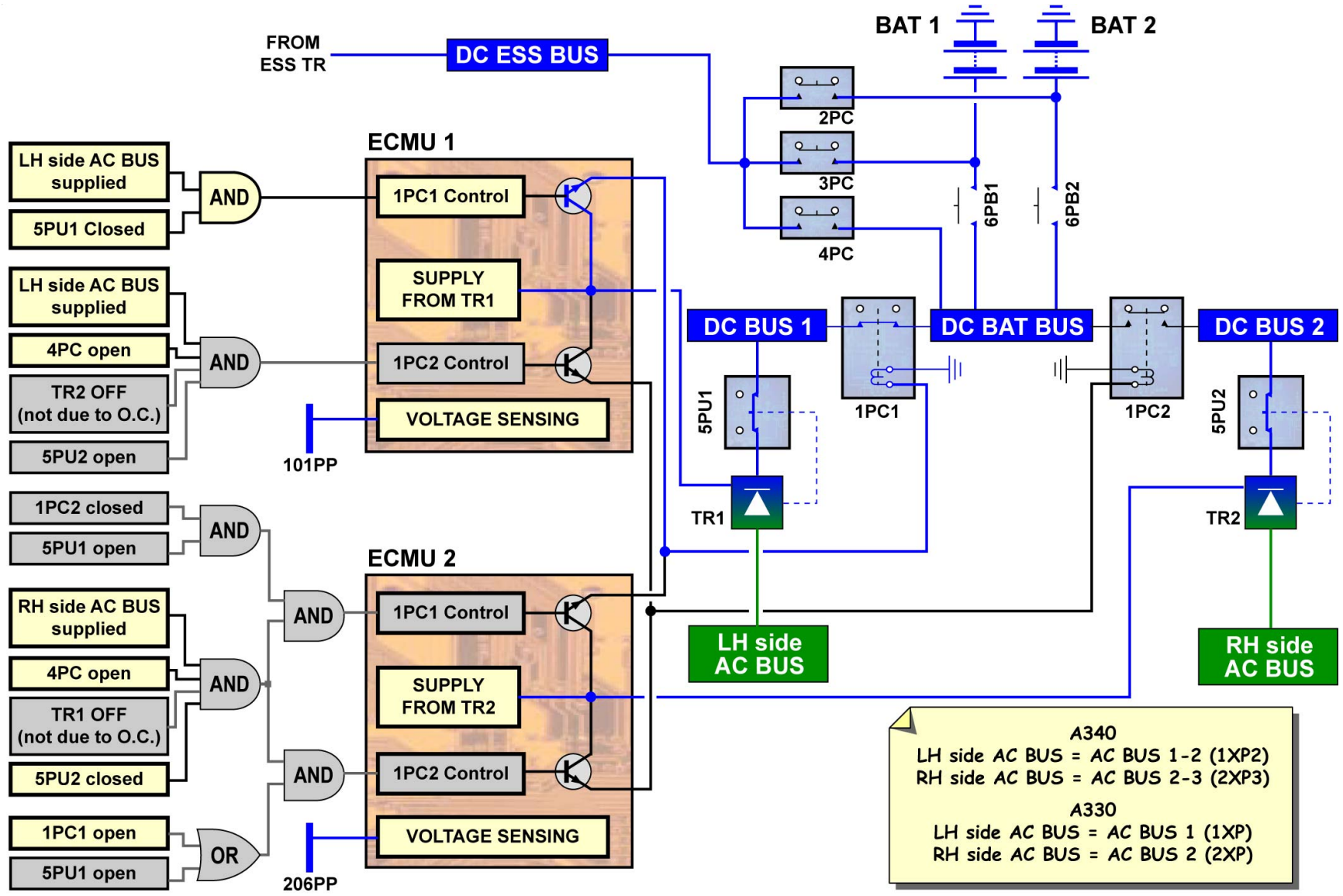

DC NORMAL GENERATION SWITCHING - DC NORMAL BUS SWITCHING ... ABNORMAL OPERATION

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EMERGENCY DC GENERATION D/O (3)

DC ESSENTIAL GENERATION SWITCHING

This topic explains the control circuit of the DC ESS power. The DC ESS network consists of:
- DC ESS BUS 4PP,
- DC ESS SHED BUS 8PP.

The control circuit enables the DC ESS network to be supplied:
- from the ESS TR in normal operation,
- from the BAT BUS in abnormal operation,
- from the BATs in emergency operation.

OPERATION

In normal supply configuration, the ESS TR supplies:
- the DC ESS bus 4PP via the TR contactor 3PE,
- and the DC ESS SHED bus 8PP via the contactor 1PH.

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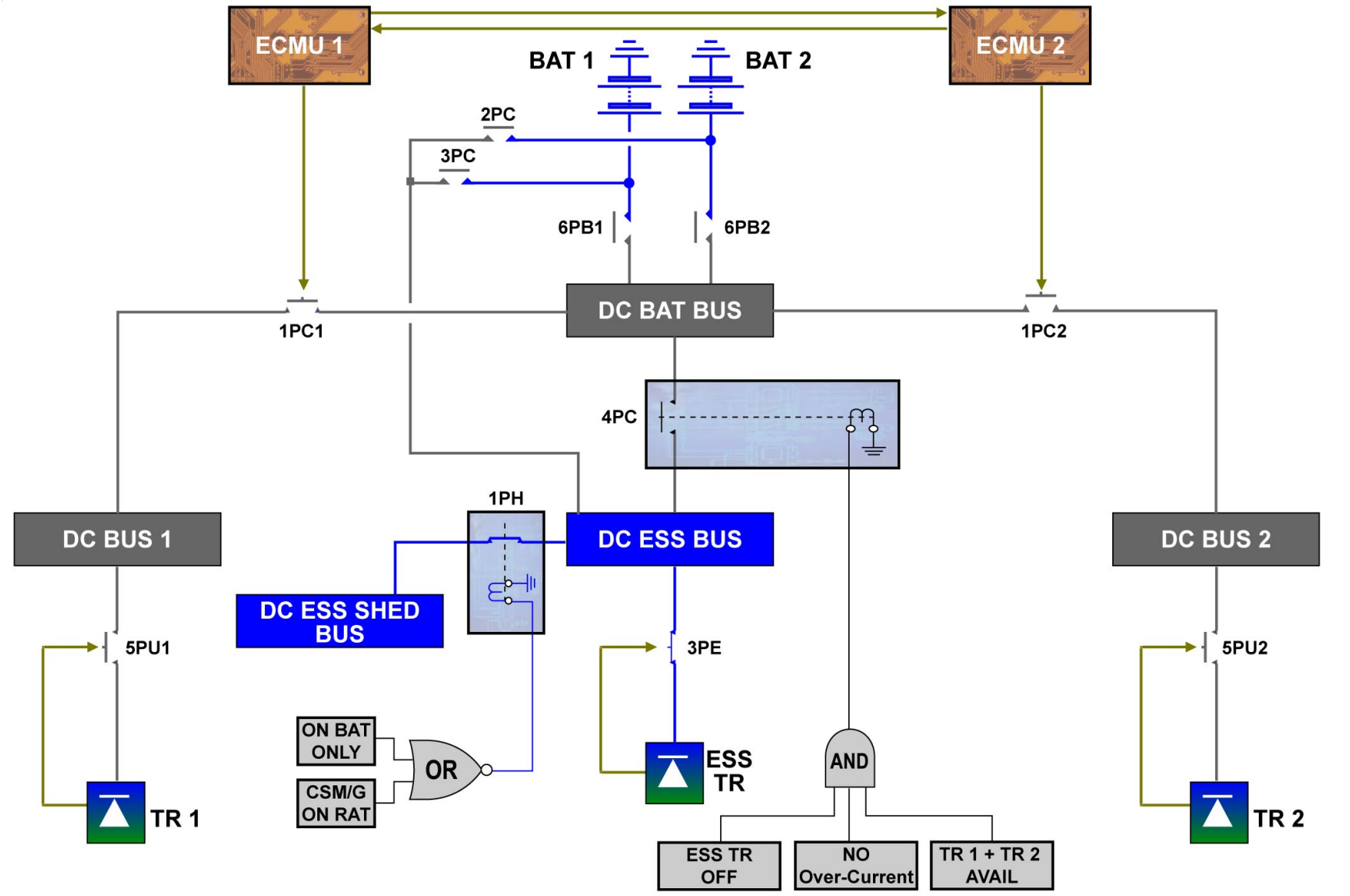

DC ESSENTIAL GENERATION SWITCHING - OPERATION

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EMERGENCY DC GENERATION D/O (3)

DC ESSENTIAL GENERATION SWITCHING (continued)

ABNORMAL OPERATION

In case of ESS TR fault, not due to over-current (3PE open), the contactor 4PC closes and connects power from BAT BUS to the DC ESS network provided:
- TR1 supplies DC BUS 1 (5PU1 closed) and BAT BUS (1PC1 closed),
- and TR2 only supplies DC BUS 2 (5PU2 closed, 1PC2 open).

In case of ESS TR fault due to over-current, the contactor 3PE opens and either opens contactor 4PC if already closed or prevents contactor 4PC from closing. The essential network is then no longer supplied.
In case of TR1 and ESS TR fault not due to over-current, 5PU1 is open and the DC ESS network is completely lost.
The TR2 maintains the supply to the DC NORMAL network (DC BUS 2, DC BAT BUS and DC BUS 1).
Principle is the same with TR2 and ESS TR faulty.

EMERGENCY OPERATION

On batteries only, the contactors 2PC and 3PC are closed and only the DC ESS BUS is supplied (1PH remains open).

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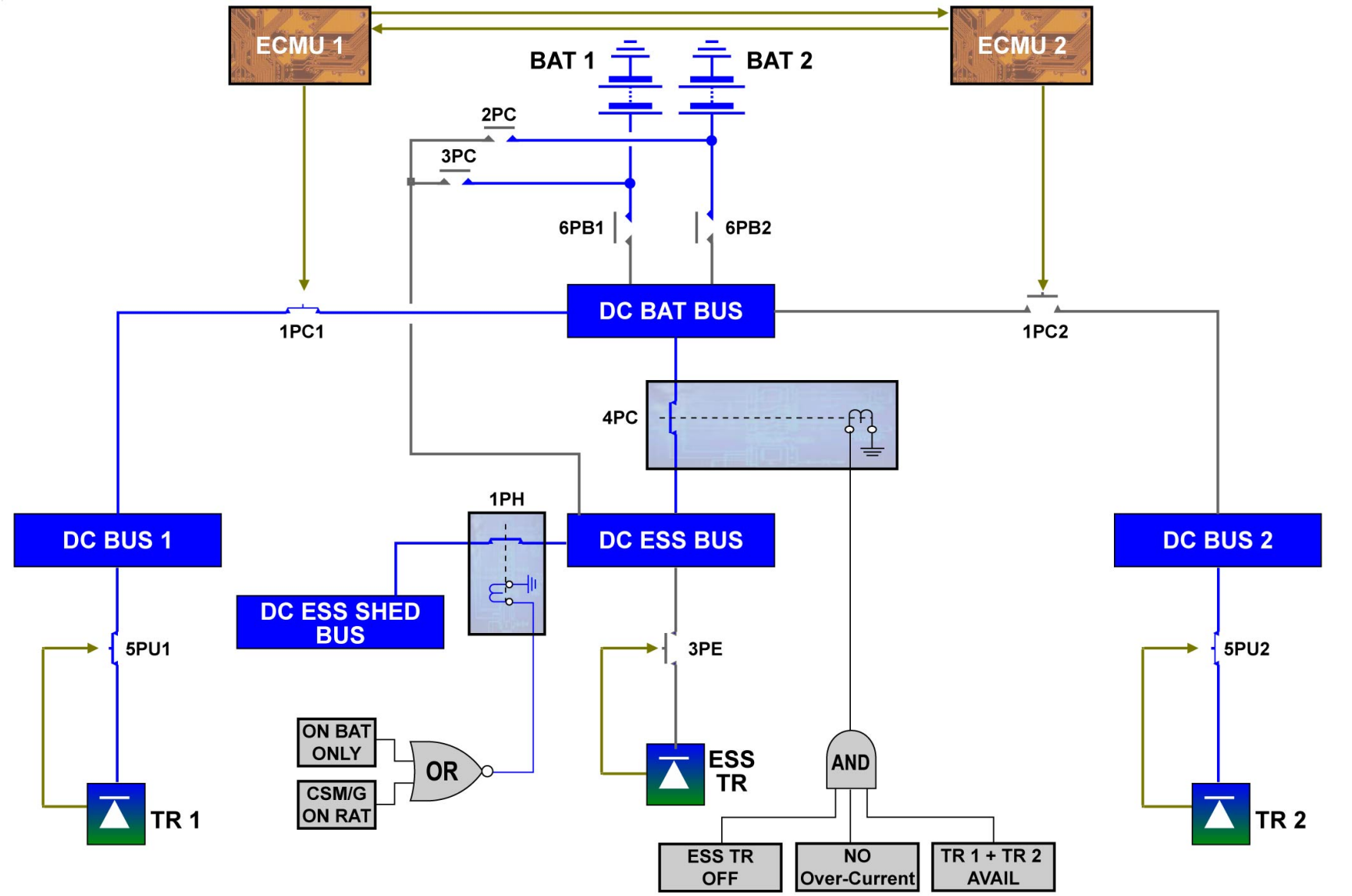

DC ESSENTIAL GENERATION SWITCHING - ABNORMAL OPERATION & EMERGENCY OPERATION

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LOAD MANAGEMENT D/O (3)

GENERAL

Electrical network of the A/C is protected from overload. Electrical Contactor Managements Units (ECMUs) protect the galley supply and sub-busbars supply from overload.
To protect the network, ECMUs open Remote Control Circuit Breakers (RCCBs) to partially or totally shed the supply of galleys and / or sub-busbars. The Remote control Circuit Breaker (RCCB) is used to fulfill the following functions: electrical line protection (circuit breaker tripping function), electrical load switching (contactor switching function).

LOAD MANAGEMENT DESCRIPTION

The ECMUs monitor parameters of the AC power source(s) and control the contactors to allow the supply of the electrical networks.
If the corresponding Generator Control Unit (GCU) or GROUND AUXILIARY POWER CONTROL UNIT (GAPCU) detect a power source overload, it sends an overload signal to ECMUs.
When ECMUs receive an overload signal, they analyze the electrical network configuration. To remove the overload condition, ECMUs directly act on the corresponding RCCBs. There are two types of RCCBs:
- RCCBs that control and protect the power supply to the galley feeders,
- RCCBs that control and protect the power supply to the sub-busbars.
In case of overload detection by an AC power source, ECMUs shed, partially or totally, the supply of galleys or sub-busbars by controlling the status of RCCBs (contactor switching function of a RCCB). Each RCCB controls directly the power supply to a galley feeder or a sub-busbar and opens automatically (circuit breaker tripping function of a RCCB) removing the power supply in case of an overload or a short circuit.
ECMUs monitor and control the opening and/or closure of the RCCBs (the contactor switching function),which allow the galleys and sub-busbars to be supplied, to enable the shedding functions. The shedding logic is defined by:
- the type of aircraft,
- the aircraft configuration (ground/flight),
- the number of available AC sources (Integrated Drive Generators (IDGs), APU GENerator, EXTernal PoWeR A/B),
- the number of installed galleys.

LOAD AUTOMATIC SHEDDING

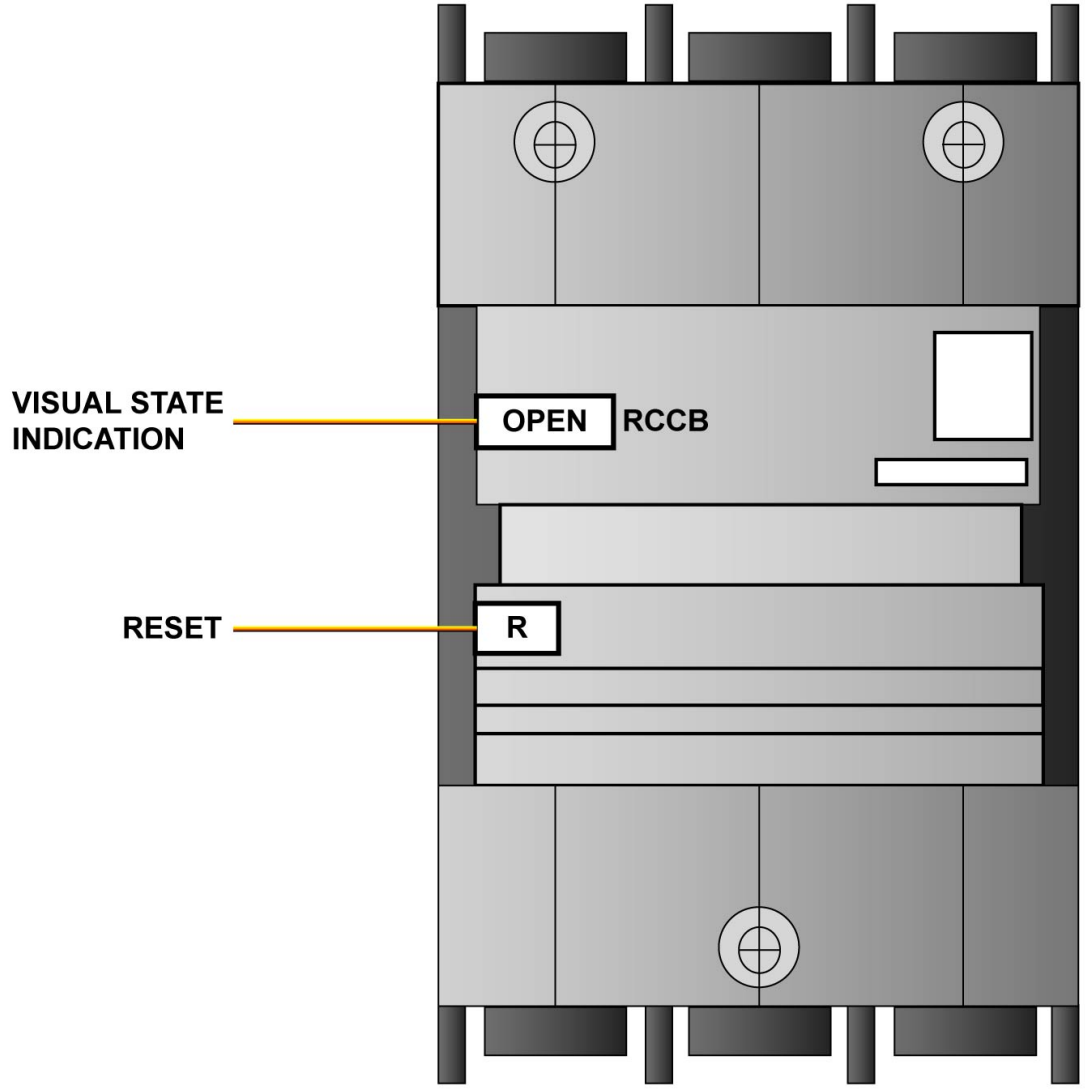
If the galley supply circuit detects an overload in galleys, a shedding is directly performed via the corresponding RCCB (the circuit breaker tripping function of a RCCB).
In case of overload detected in a sub-busbar, the corresponding RCCB removes the power to the sub-busbar (circuit breaker tripping function of a RCCB). When an AC power source is in overload condition (GEN 1 for example), ECMUs calculate the input load from the power sources and the output load to the galleys and other consumers.
In case of an AC power source overload, the ECMUs can shed (via RCCBs contactor switching function) the galley supply or sub-busbar supply partially or completely in accordance with a shedding sequence priority. These shedding operations could also result from a loss of an AC electrical power sources (for example the loss of a GEN).

LOAD MANUAL SHEDDING

A complete shedding of the galleys can be performed by manually selecting the GALLEY P/BSW to OFF. The GALLEY P/BSW can also be used to reset the galleys loads and sub-busbar loads automatically shed after overload detected by an AC power source.
The function of the GALLEY P/BSW is only operative when the AC Main Distribution COMMERCIAL P/BSW is in its ON position.
When the COMMERCIAL P/BSW is released, the OFF legend comes on, all galleys, sub-busbars and all service buses are no longer supplied.

LOAD RESTORATION

A manual reset (contactor function of a RCCB) can be performed through the RESET P/BSW located on the front face of ECMU or through an ECMU test using the CMS or using the GALLEY P/BSW (for galley and sub-busbar RCCBs) by cycling the GALLEY P/BSW to OFF then back to AUTO. When a RCCB opens automatically after an overload detection (circuit breaker tripping function), it is possible to reset the RCCB by manually pushing the corresponding RCCB RESET P/B, located on the front face of the RCCB. The circuit breaker tripping function is indicated on the RCCB by the RESET P/BSW released (out position) and the visual indication on the RCCB indicates OPEN.



GENERAL - LOAD MANAGEMENT DESCRIPTION ... LOAD RESTORATION

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LOAD MANAGEMENT D/O (3)

GENERAL (continued)

INDICATING

The status of each RCCB (open or closed) is shown on a visual indication on the front face of the RCCB.
According to the load shed, the ECMUs transmit three different messages to the System Data Acquisition Concentrators (SDACs) by ARINC 429 buses for flight deck indication of load shedding.
These messages are shown on the ELEC AC page according to the aircraft configuration.
Each of these three messages indicates a shed configuration:
- if part of the galley loads are shed and no other system is shed, the GALLEY PARTIALLY SHED message is displayed, in addition the message PART GALLEY is shown in amber on the ECAM STATUS page under the INOP column,
- if all galley loads are shed, the GALLEY SHED message is displayed, in addition the message GALLEY in amber is shown on the ECAM STATUS page under the INOP column,
- if all the managed loads are shed, the COMMERCIAL OFF message is displayed, in addition the message COMMERCIAL is displayed in amber on the ECAM STATUS page under the INOP column.
In case of automatic shedding failure, the FAULT legend of the GALLEY P/BSW comes on amber and ECAM caution comes on, when an overload is detected, and if the automatic shedding is not performed.

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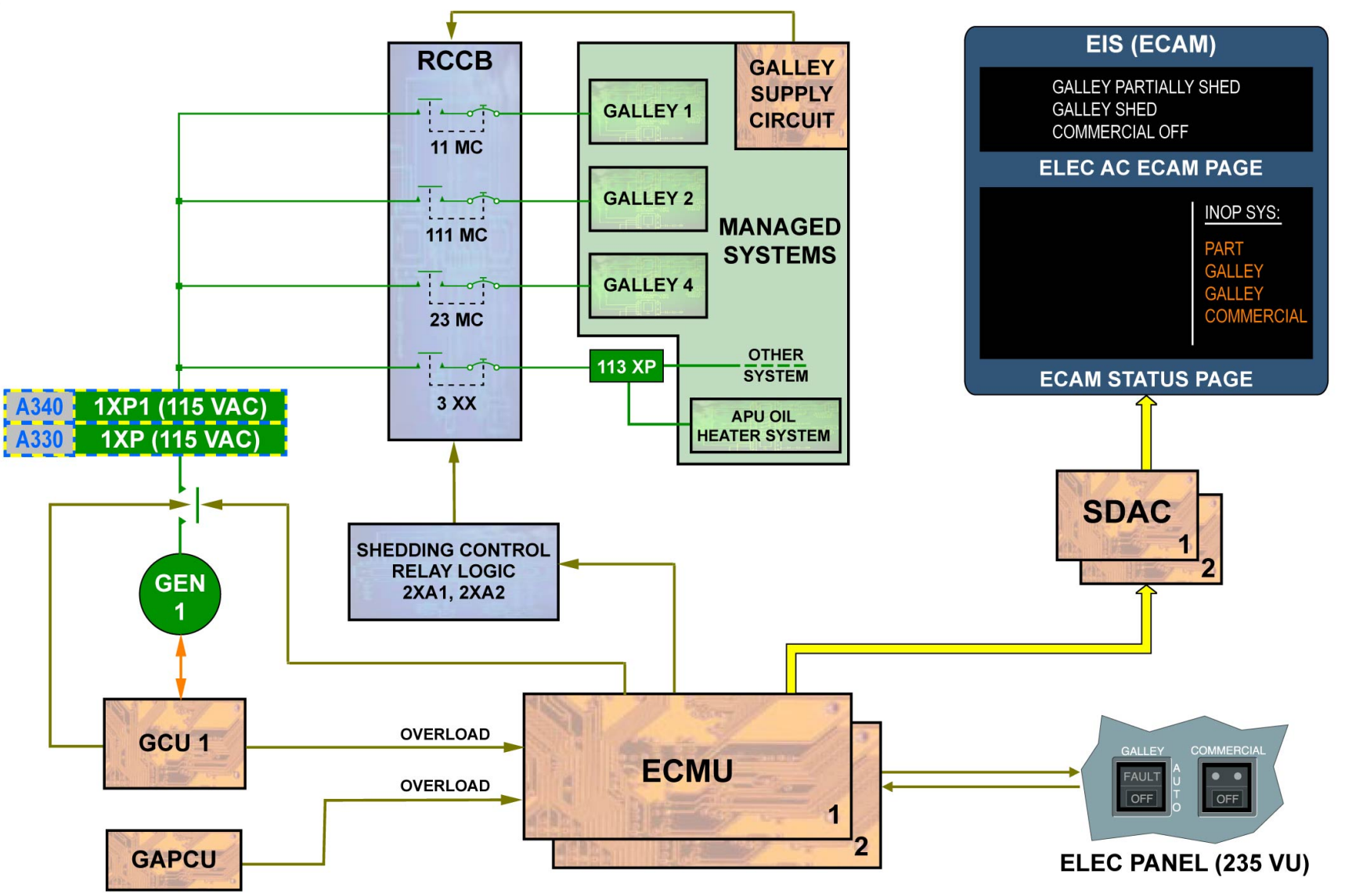

GENERAL - INDICATING

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REFUEL ON BATTERY D/O (3)

GENERAL

The refueling ELECtrical network is normally supplied by the A/C network.
If the A/C network is not supplied, the BATteries can be used as a power source.
The refueling operation can be made according to 3 different configurations:
- Normal configuration,
- Ground service configuration,
- Battery only configuration.

NORMAL CONFIGURATION

In normal supply configuration, the refueling ELEC network is supplied either by the EXTernal PoWeR, the APU GENerator or the main GENerators.

GROUND SERVICE CONFIGURATION

In ground service supply configuration, the refueling ELEC network is supplied by the EXT PWR A only via the MAINTenance BUS P/BSW without energizing the whole A/C network.

BATTERY ONLY CONFIGURATION

In BATs only configuration, the ELEC network is supplied by the main BATs.

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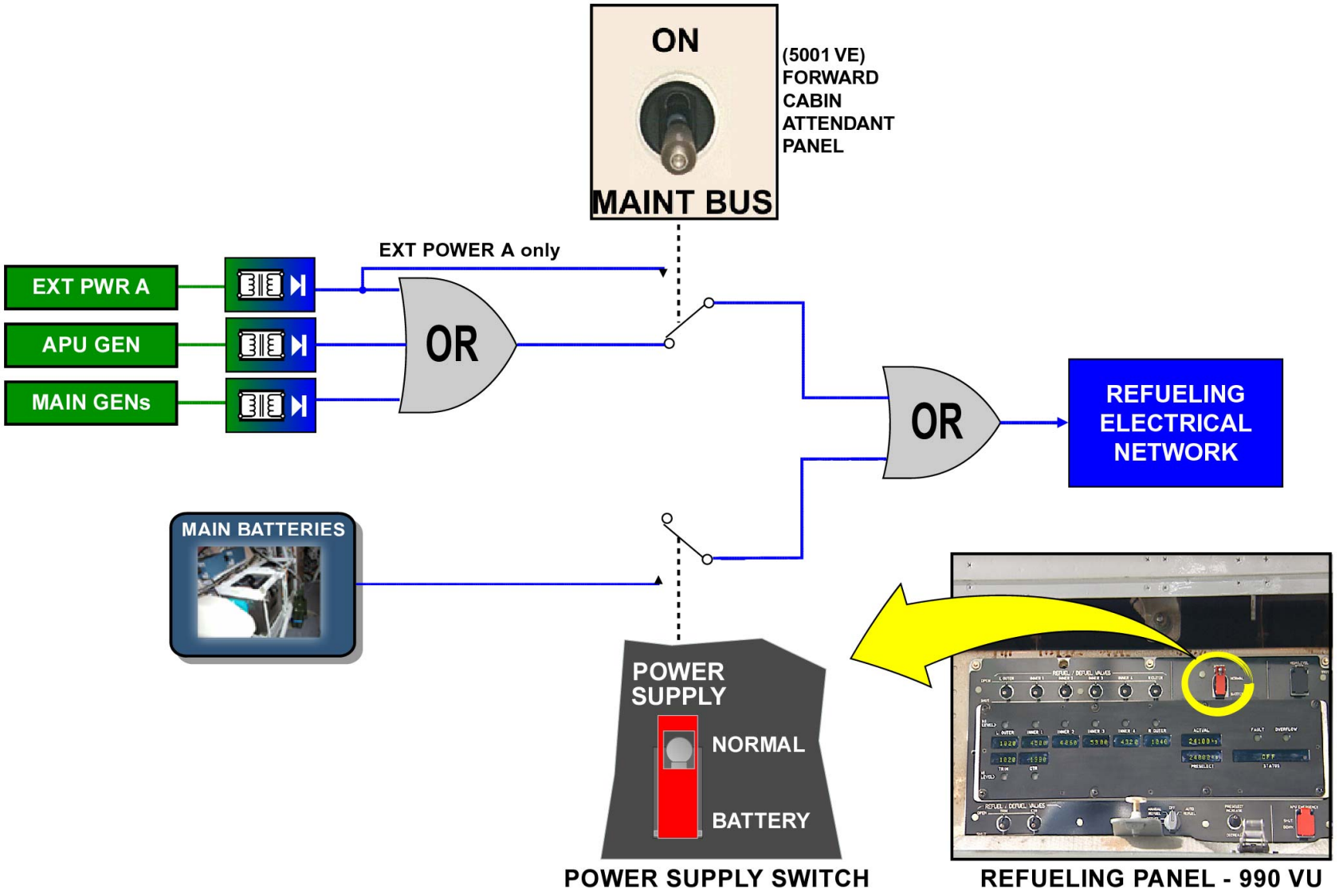

GENERAL ... BATTERY ONLY CONFIGURATION

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